CHAPTER 1

INTRODUCTION

1.1 GENERAL

Intelligent Transportation System (ITS) is the application of computer, electronics and communicational technologies and management strategies in an integrated manner to improve travel information and hence increase the safety and efficiency of the surface transportation system. This system involves vehicle, driver, passengers, road operators, managers and the environment all interacting with each other and linking with the complex infrastructure system to improve the safety and capacity of road system.

Information technology (IT) has transformed many industries from education to health care, and is now in the early stages of transforming transportation systems. While many think improving a country's transportation system solely means building new roads or repairing aging infrastructures, the future of transportation not only lies in concrete and steel, but it lies in using ITS. ITS enables elements within the transportation system like vehicles, roads, traffic lights, message signs, etc. to become intelligent by embedding them with microchips and sensors and empowering them to communicate with each other through wireless technologies. Among the leading nations in the world, ITS brings significant improvement in transportation system performance, including reduced congestion and increased safety and traveler convenience.

As reported by Commission for Global Road Safety (June 2006) , the global road deaths were between 750,000 to 880,000 in the year 1999 and estimated about 1.25 million deaths per year and the toll is increasing further. World health organization report (1999), showed that in the year 1990 road accidents as a cause of death or disability were the ninth most significant cause of death or disability and predicted that by 2020 this will move to sixth place. Without significant changes to the road transport systems these dreadful figures are likely to increase significantly.

Traditional driver training, infrastructure and safety improvements, may contribute to certain extent to reduce the number of accidents but not enough to combat this menace. ITS is the best solution to the problem. Safety is one of the principal driving forces behind the evolution, development, standardization, and implementation of ITS systems.

ITS improve transportation safety and mobility and enhances global connectivity by means of productivity improvements achieved through the integration of advanced communications technologies into the transportation infrastructure and in vehicles. Intelligent transportation systems encompass a broad range of wireless and wire line communication based information and electronics technologies to better manage traffic and maximize the utilization of the existing transportation infrastructure. It improves driving experience, safety and capacity of road systems, reduces risks in transportation, relieves traffic congestion, improves transportation efficiency and reduces pollution.

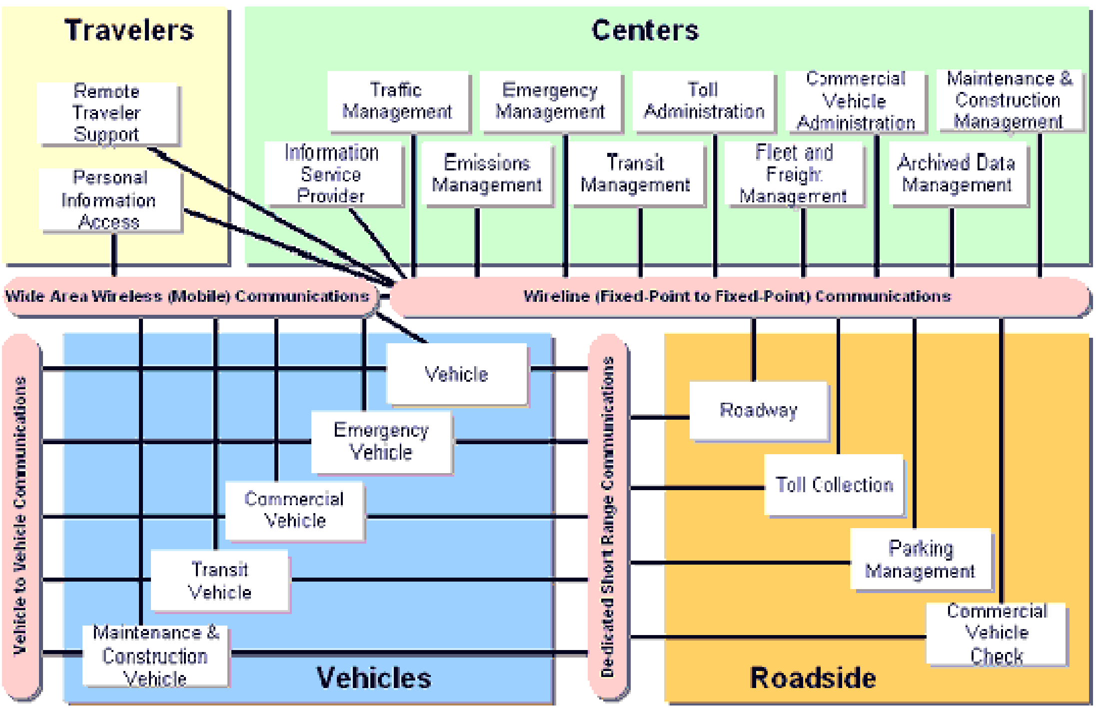

Fig No. 1.1(1) Broad overview of ITS

1.2 TECHNOLOGY IN USE

The area of ITS supported by three following technologies such as:

1.2.1 WIRELESS COMMUNICATIONS

Various forms of wireless communications technologies have been proposed for intelligent transportation systems. Modem communication on UHF and VHF frequencies are widely used for short and long range communication within ITS.

Short-range communications of 350 m can be accomplished using IEEE 802.11 protocols, specifically WAVE or the Dedicated Short Range Communications standard being promoted by the Intelligent Transportation Society of America and the United States Department of Transportation. Theoretically, the range of these protocols can be extended using Mobile ad hoc networks or Mesh networking.

Longer range communications have been proposed using infrastructure networks such as Wi-MAX (IEEE 802.16), Global System for Mobile Communications (GSM), or 3G. Long-range communications using these methods are well established, but, unlike the short-range protocols, these methods require extensive and very expensive infrastructure deployment. There is lack of consensus as to what business model should support this infrastructure.

Auto Insurance companies have utilized ad hoc solutions to support e-Call and behavioral tracking functionalities in the form of Telematics 2.0.

1.2.2 COMPUTATIONAL TECHNOLOGIES

Recent advances in vehicle electronics have led to a move towards fewer, more capable computer processors on a vehicle. A typical vehicle in the early 2000s would have between 20 and 100 individual networked microcontroller/Programmable logic controller modules with non-real-time operating systems. The current trend is toward fewer, more costly microprocessor modules with hardware memory management and real-time operating systems. The new embedded system platforms allow for more sophisticated software applications to be implemented, including model-based process control, artificial intelligence, and ubiquitous computing. Perhaps the most important of these for Intelligent Transportation Systems is artificial intelligence.

1.2.3 FLOATING CAR DATA/FLOATING CELLULAR DATA

"Floating car" or "probe" data collected other transport routes. Broadly speaking, four methods have been used to obtain the raw data:

TRIANGULATION METHOD: - In developed countries a high proportion of cars contain one or more mobile phones. The phones periodically transmit their presence information to the mobile phone network, even when no voice connection is established. In the mid-2000s, attempts were made to use mobile phones as anonymous traffic probes. As a car moves, so does the signal of any mobile phones that are inside the vehicle. By measuring and analyzing network data using triangulation, pattern matching or cell-sector statistics (in an anonymous format), the data was converted into traffic flow information. With more congestion, there are more cars, more phones, and thus, more probes. In metropolitan areas, the distance between antennas is shorter and in theory accuracy increases. An advantage of this method is that no infrastructure needs to be built along the road; only the mobile phone network is leveraged. But in practice the triangulation method can be complicated, especially in areas where the same mobile phone towers serve two or more parallel routes (such as a motorway (freeway) with a frontage road, a motorway (freeway) and a commuter rail line, two or more parallel streets, or a street that is also a bus line). By the early 2010s, the popularity of the triangulation method was declining.

VEHICLE RE-IDENTIFICATION:-Vehicle re-identification methods require sets of detectors mounted along the road. In this technique, a unique serial number for a device in the vehicle is detected at one location and then detected again (re-identified) further down the road. Travel times and speed are calculated by comparing the time at which a specific device is detected by pairs of sensors. This can be done using the MAC addresses from Bluetooth or other devices,[4] or using the RFID serial numbers from electronic toll collection (ETC) transponders (also called "toll tags").

GPS BASED METHODS: - An increasing number of vehicles are equipped with in-vehicle satnav/GPS (satellite navigation) systems that have two-way communication with a traffic data provider. Position readings from these vehicles are used to compute vehicle speeds. Modern methods may not use dedicated hardware but instead Smartphone based solutions using so called Telematics 2.0 approaches.

SMARTPHONE - BASED RICH MONITORING: - Smartphones having various sensors can be used to track traffic speed and density. The accelerometer data from smartphones used by car drivers is monitored to find out traffic speed and road quality. Audio data and GPS tagging of smartphones enables identification of traffic density and possible traffic jams. This was implemented in Bangalore, India as a part of a research experimental system Nericell.

Floating car data technology provides advantages over other methods of traffic measurement:

- Less expensive than sensors or cameras
- More coverage (potentially including all locations and streets)
- Faster to set up and less maintenance
- Works in all weather conditions, including heavy rain

1.2.4 SENSING TECHNOLOGIES

Technological advances in telecommunications and information technology, coupled with ultramodern/state-of-the-art microchip, RFID (Radio Frequency Identification), and inexpensive intelligent beacon sensing technologies, have enhanced the technical capabilities that will facilitate motorist safety benefits for intelligent transportation systems globally. Sensing systems for ITS are vehicle- and infrastructure-based networked systems, i.e., intelligent vehicle technologies. Infrastructure sensors are indestructible (such as in-road reflectors) devices that are installed or embedded in the road or surrounding the road (e.g., on buildings, posts, and signs), as required, and may be manually disseminated during preventive road construction maintenance or by sensor injection machinery for rapid deployment. Vehicle-sensing systems include deployment of infrastructure-to-vehicle and vehicle-to-infrastructure electronic beacons for identification communications and may also employ video automatic number plate recognition or vehicle magnetic signature detection technologies at desired intervals to increase sustained monitoring of vehicles operating in critical zones.

1.2.5 INDUCTIVE LOOP DETECTION

Inductive loops can be placed in a roadbed to detect vehicles as they pass through the loop's magnetic field. The simplest detectors simply count the number of vehicles during a unit of time (typically 60 seconds in the United States) that pass over the loop, while more sophisticated sensors estimate the speed, length, and class of vehicles and the distance between them. Loops can be placed in a single lane or across multiple lanes, and they work with very slow or stopped vehicles as well as vehicles moving at high speed.

1.2.6 VIDEO VEHICLE DETECTION

Traffic-flow measurement and automatic incident detection using video cameras is another form of vehicle detection. Since video detection systems such as those used in automatic number plate recognition do not involve installing any components directly into the road surface or roadbed, this type of system is known as a "non-intrusive" method of traffic detection. Video from cameras is fed into processors that analyses the changing characteristics of the video image as vehicles pass. The cameras are typically mounted on poles or structures above or adjacent to the roadway. Most video detection systems require some initial configuration to "teach" the processor the baseline background image. This usually involves inputting known measurements such as the distance between lane lines or the height of the camera above the roadway. A single video detection processor can detect traffic simultaneously from one to eight cameras, depending on the brand and model. The typical output from a video detection system is lane-by-lane vehicle speeds, counts, and lane occupancy readings. Some systems provide additional outputs including gap, headway, stopped-vehicle detection, and wrong-way vehicle alarms.

1.2.7 BLUETOOTH DETECTION

Bluetooth is an accurate and inexpensive way to measure travel time and make origin and destination analysis. Bluetooth is a wireless standard used to communicate between electron dresses from Bluetooth devices in passing vehicles. If these sensors are interconnected they are able to calculate travel time and provide data for origin and destination matrices. Compared to other traffic measurement technologies, Bluetooth measurement has some differences:

- Accurate measurement points with absolute confirmation to provide to the second travel times.
- Is non-intrusive, which can lead to lower-cost installations for both permanent and temporary sites.
- Is limited to how many Bluetooth devices are broadcasting in a vehicle so counting and other applications are limited.
- Systems are generally quick to set up with little to no calibration needed.

Since Bluetooth devices become more prevalent on board vehicles and with more portable electronics broadcasting, the amount of data collected over time becomes more accurate and valuable for travel time and estimation purposes.

1.2.8 AUDIO DETECTION

It is also possible to measure traffic density on a road using the Audio signal that consists of the cumulative sound from tire noise, engine noise, engine-idling noise, honks and air turbulence noise. A roadside-installed microphone picks up the audio that comprises the various vehicle noise and Audio signal processing techniques can be used to estimate the traffic state. The accuracy of such a system compares well with the other methods described above.[6]

Information fusion from multiple traffic sensing modalities

The data from the different sensing technologies can be combined in intelligent ways to determine the traffic state accurately. A Data fusion based approach that utilizes the road side collected acoustic, image and sensor data has been shown to combine the advantages of the different individual methods

1.3 HISTORY OF ITS

The origin of the formal ITS program dates back to the nineteen sixties with the development of the Electronic Route Guidance System (ERGS) in the United States, to provide drivers with route guidance information based on real-time traffic analysis. The system used special hardware located at various intersections across the road network, on-board 2-way devices in vehicles that would form the hub of communication between the driver and the ERGS system, and a central computer system that processed the information received from the remote systems. During the early seventies, the ERGS program led to a more sophisticated, automated system comprising interactive visual digital maps called the Automatic Route Control System (ARCS). The Urban Traffic Control System was developed concomitantly, connecting various traffic signals and computer generated predetermined signal timings for better traffic organization. The same era saw the development of the Japanese Comprehensive Automobile Traffic Control System (CATCS) program, presumably one of the earliest public-private partnership effort in the world to test an interactive route guidance system with an in-vehicle display unit. The Autofahrer Leit and Information System (ALI System) in Germany was a dynamic route guidance system based on real traffic conditions, employed in the seventies. This was followed by AMTICS and RACS projects that heralded the era of high-tech traffic management in Japan. Meanwhile, the United States strove to formulate the Federal Transportation Bill, the successor to the Post Interstate Bill of the fifties, to solve issues of growing traffic congestion, travel related accidents, fuel wastage and pollution. In 1986, the Intelligent Vehicle Highway System (IVHS) was formulated that led to a spate of developments in the area of ITS. The General Motors-funded Highway Users Federation for Safety and Mobility Annual Meeting (HUFSAM) was held in Washington DC in November, 1986 to partner with the US DOT in sponsoring a National Leadership Conference on “Intelligent Vehicle Highway System (IVHS)”.

A Federal Advisory Committee for IVHS was incorporated to assist the US-Department of Transportation and was aimed to promote orderly and expeditious movement of people and goods, develop an efficient mass transit system that interacts smoothly with improved highway operations and an active IVHS industry catering to both domestic and international needs. This laid the foundation for the formal Intelligent Transportation Society of America (ITS America) in 1991 as a non-profit organization to foster the use of advanced technologies in surface transportation systems. In Europe, the Program for a European Traffic System with Higher Efficiency and Unprecedented Safety (Prometheus) was designed by auto manufacturers and this was followed by Dedicated Road Infrastructure.

1.4 PROBLEM IN THE APPLICATION

The rapidly advancing economy of India, in par with the rest of the world has resulted in a phenomenal increase in use of personal automobiles on Indian urban roads. The cumulative growth of the Passenger Vehicles segment in India during April 2007 – March 2008 was 12.17 percent. In 2007-08 alone, 9.6 million motorized vehicles were sold in India. It is expected that India will surpass China as the fastest growing car market within the next few years. Economy-induced automobile usage is complicated further by the constant influx of rural population into urban areas, thus making enormous demands on the transportation infrastructure in an overloaded region. In 2001, India had 35 cities with a population of more than one million people. The heterogeneity of economy and the physical limit on how much additional infrastructure a city can hold complicate transport management further.

Some of the main issues facing the deployment of ITS in developing countries like India, reported by a World Bank study are: an underdeveloped road network, severe budget restrictions, explosive urbanization and growth, lack of resources for maintenance and operation, less demand for automation, lack of interest among government decision makers, and lack of user awareness. While a number of small scale ITS projects have been introduced in various cities in India including New Delhi, Pune, Bangalore, Indore and Chennai - these systems have focused on isolated deployments such as of parking information, area-wide signal control, advanced toll collection, web based traveler information etc. Most of these are small-scale single city based pilot studies. At present, there are not many comprehensive, fully developed ITS applications with traffic management centers in India. Thus, it can be seen that the penetration of ITS in Indian road scenario is relatively less and much more is needed to be done. To make this a reality, there is a need for more systematic approach to the ITS implementation.

Apart from the applications that are already being developed/implemented, there are more ITS concepts that will be useful in the Indian scenario such as emergency management, congestion management, advanced traffic management systems, advanced traveler information systems, commercial vehicle operations, advanced vehicle control systems, etc. Full utilization of ITS can be achieved only by implementation at a network level rather than in small corridors. Overall, the existing applications shows an initial promise and potential for the deployment of ITS in India and give an initial empirical basis and data on ITS deployment highlighting the data, methodological, practical and research challenges for Indian conditions. Some of specific actions required to meet the challenges to ITS in India include:

Evolving a national ITS standard for different ITS applications and their components Setting up a national ITS clearinghouse that documents all ITS projects with details on the design, implementation, lessons learned/best practices, and cost-benefit details Setting up fully functional Traffic Management Centers for coordinating the urban and regional ITS activities, Developing and implementing automated traffic data collection methodologies, Developing a national ITS data archive, Developing models and algorithms suitable for ITS implementations Fostering more interaction between academia, industries and governmental agencies to generate more interest and in turn projects in the ITS area. These can be achieved through improvements in the following areas:

1.4.1 TECHNOLOGY IMPROVEMENTS

ITS implementations in India cannot be carried out by reproducing what is done in developed countries because of a range of cultural, lifestyle and physical differences among them. The diverse range of vehicular velocities (pedestrian, bicycle, LMV's, HMV's, animal drawn carts), wide variety of vehicles (including pedestrian traffic), and poor lane discipline (partially resulting from the first two factors and partially due to cultural reasons) and a very high population density makes implementation of Western ITS standards and architecture difficult. Data collection techniques are difficult under Indian traffic conditions. For example detectors which are lane based are inapplicable due to the above reasons. Probe vehicle methods such as AVI and AVL are expensive and need public participation. Budgetary limitations make implementation of such methods hard. Video techniques can collect data despite lack of lane discipline and homogeneity. However, extraction software that can be used to extract data is available only for a limited class of vehicles and for lane based traffic. Such software to extract real time data from video under the commonly seen heterogeneous/mixed traffic conditions is not available making video also not a good data source for real time applications. The pressing need towards developing a comprehensive ITS program for India requires the development of cost effective detection techniques for road-wide data collection rather than lane-centric collection that are suitable for a more orderly traffic flow. Further, the ITS data are not effectively utilized as of now. Once such a real time automated data collection system is developed the data generated can be archived and can be used for model development.

1.4.2 INFRASTRUCTURE

Apart from data collection and management, there is a need to improve road and highway infrastructure to channel the burgeoning traffic into less congested routes. Major metropolitan cities are continually addressing this issue by building flyovers and subways, widening roads and designating one-way roads during peak hours. The infrastructure growth is, however, restricted by space constraints and cannot by itself solve the problems that plague the Indian roads today. Another important approach to ITS is to advance public transportation as a competitive alternative to private transport. India is the second largest producer of buses, accounting for 16 percent of world's total bus production. Improving the quality of public transportation will encourage more usage and therefore help in transportation management.

1.4.3 SOCIAL SCHEMES

Carpooling is being increasingly considered in the developed countries to solve issues of pollution and traffic snarls during peak hours. A few arterial roads such as the beltway around Washington DC levy fines for travelling in carpool-only lanes as single occupants. There have been some trials on the enforcement of carpooling in a few Indian metros. For example, the Mumbai Environmental Social Network has promoted a web- and SMS-based pooling system. Bangalore Transport Information System has a group-SMS version. Since it is illegal for a private motorist to charge for lifts, Koolpool with the help of Hindustan Petroleum, has devised a scheme which permits pick-ups at its petrol pumps in return for a petrol voucher worth Rs.25 for giving a lift. Such schemes can be fine-tuned to make it more profitable for the public and useful for the city’s traffic. Chennai in recent years, has seen the increased use of the “share auto”, an automobile pooling convenience, not in the scale of buses, but less expensive than the common "auto rickshaw". Such schemes have caught on well and further developments along such ideas can provide a much needed breather for the traffic jams that characterize the cities. Some other cities around the world such as Singapore and London have introduced congestion charging schemes to reduce traffic. Such schemes ensure optimal usage of those specific roads, provide financial backup for road infrastructure maintenance and encourage the use of public transportation.

1.5 OBJECTIVE AND SCOPE OF ITS

1.5.1 OBJECTIVE

Over the last couple of years, there has been significant increase in the interest in ITS research. The main objective of Intelligent Transportation systems is to provide solution to the current drawbacks in transportation systems, and to provide a reliable bus service network which will attract more people to use the same, reduce air pollution by motivating people to use public transport system, it provides a lot of advantages with a modification to the current infrastructure and systems.

Core Objectives of ITS

- To Improve Traffic Safety
- To Relieve Traffic Congestion
- To Improve Transportation Efficiency
- To Reduce Air Pollution
- To reduce the fuel consumption
- To Promote Greenery
- Better Travel Information

1.5.2 SCOPE

Intelligent travel systems do have a larger scope in the future, probably more in the developing countries than in the developed ones. Slowly but gradually all transport and rapid transit systems will continue to adopt a smarter way for ticketing and management of the systems so that the old technologies and mechanisms will slowly cease to exist. Smart cards, token travel, comfort, ease, speed, in-transit entertainment, clean station premises, clean and green energy to power those systems will soon be a reality, once the governments and the citizens start to co-operate.

Global intelligent transportation system (ITS) market was valued USD 18.04 billion in 2014, with estimation of USD 47.6 billion by 2022, growing at 13% from 2015 to 2022.

Worldwide demand in traffic management system was USD 5.6 billion in 2014 which is probable to achieve USD 14 billion by 2022, growing at a CAGR of 12% from 2015 to 2022. Advantages offered by this system include operation performance and reliability are predictable to stimulate the industry demand. Public transport is expected to grow at 13.3% over the forecast period. North America leads the regional demand with market share of 41.52% in 2014. Stringent government norms have boosted the demand in this region over the forecast period. Asia Pacific region is expected grow at high rates compared to other regions. The region is expected to grow at a CAGR of 13.9% up to 2022. Reasonably competitive industry consists of top ten manufacturers which accounts large percentage of industry share in 2013. Major industry manufacturers include Siemens AG, Hitachi Ltd., Kapsch Traffic.Com, SWARCO AG, Denso, Q-Free ASA, TomTom NV, Garmin International, IBM Corp. and Xerox Corp.

The scope of this project is very wide in case of Delhi Region. As we know that traffic congestion is major problem of Delhi, also the mode of transport available is not appreciable. So if this system is applied in Delhi region it will help in improving the transportation facilities as well as reduce the rate of accidents. It also help to improve the incident management and response capabilities of public transport and public safety officials ,the towing and recovery industry and others involve in the incident responses. Advance sensors, data processor and communicational technologies are used to identify the incident.

1.6 EXPECTED OUTCOME

The invention of the internal combustion engine in the nineteenth century changed the way people travel forever. For the first time in human history it became possible for human beings to achieve travel speeds an order of magnitude greater than they had ever experienced before. Even better, they did not have to use their own energy in any significant manner to do so. This quality of the motor car has almost everyone addicted to its use if they can afford to buy and use one. From just a handful of vehicles a century ago, now there are more than 500 million cars, buses and trucks on the roads around the world, and the number continues to increase. Road transport makes it easier for us to have access to jobs, schooling, markets, and leisure time activities and helps economic growth. However, now there are serious concerns about the detrimental impact of transport on human health and the environment. The negative externalities include: accidents, air pollution, congestion, climate change, noise, and spoiling of the landscape and urban environment. More recently, concerns about global warming focused our attention on transport as it accounts for about a fifth of all greenhouse gas emissions, mainly carbon dioxide from fuel burnt on the roads by vehicles.
After the application of this technology the outcome will be the followining:

- **Air pollution control**: Road transport is the major source of air pollution which has caused impact on human health and environment quality. Various models and protocols are used in ITS to control air pollution.
- **Safety**: considering the increasing number of accidents roads, safety is the most important need for a good bus service. Analyzing the reason for the accidents, it is found that rash and negligence on the part of the people is the main reason for the accidents. Mechanical failures constitute a very small proportion. Therefore the application ITS helps to reduce the rate of accident.

- **Reliability**: ITS makes bus service reliable in the sense that it must follow schedule and the time table. Reducing the number of breakdowns on the roads and increasing operational ratio is required. This would also include removal of undesirable driving practices like over speeding, missing stops, illegal practices.
- **Promote Eco-Friendly Transport:** ITS technologies are focused on fuel-efficient operation of vehicle and traffic management system to achieve better fuel economy and lower tailpipe emission without compromising the safety of driver or other road user.

CHAPTER 2

LITERATURE REVIEW

These are some journals which is related to our project.

Singh B and Gupta A (2012) in their study addressed the issue of increasing problems in the traffic management with the help of new technologies used in ITS. Particularly in developing countries like India, Brazil, South Africa etc. ITS is still new concept. This study addressed primarily four major elements of ITS i.e., Advanced Traveler Information System (ATIS), Advanced Public Transportation System, Advanced Traffic Management System (ATMS) and Emergency Management System (EMS). The objective of this study was to understand different models and architectures used in ITS developed over the period by different researchers. The use of GIS and WWW platforms in ITS system have their own advantages which are explored by developed countries. The GPS technology have high analysis capability while WWW platform operates on real time information processing. The synchronization of these two technology can be highly useful. By these technology use travel time and response time can get decreased considerably. In developing countries while implementing ITS mixed traffic conditions are required to be considered. The installation and operating cost of ITS implementation is crucial factor in the developing countries. The new technology like Zigbee and RFID can also be useful in future. The mobile phone penetration is high which can also be useful gazette in implantation of ITS.

We have taken this article because we have to consider different modes of ITS that can be applied in our area (Delhi Region). As from this article we get to know that there are some new technology like (zigbee, RFID), which is going to improve transportation at a greater level.

Kandar D et al explained in their study that the ITS designed with target of achieving aim of safety and non-safety applications. The combination of communication and remote sensing technology will yields into effective and robust system. The RADAR location technology combined with sensing technology is considered in this study. The moving target tracked on RADAR receiver, this signal information processed by RAKE receiver. The MATLAB simulation model able to calculate BER (Bit error rate) and PER (Packet error rate) also finds the target. As in DSRC system SS technology is used which results into no extra channel requirement for RADAR operation. The physical size of RADAR plays crucial role in commercial application of it in the vehicles.

We have taken this article because RADAR system has been introduced to improve the location access.

Dr. R. D. Raut and et al presented in their work that financial problems are the core issues in the enforcement of Intelligent Public Transport System (IPTS) in developing countries. Wireless Sensor Network (WSN) have high potential in remote traffic monitoring and target tracking etc., but it is difficult to select suitable WSN for good performance for developing countries. Researcher illustrated sensors techniques and factors affecting selection of sensors. A case study approach with emphasis on estimation of cost of IPTS with various WSNs in reference with Rajasthan State has carried out. The on board sensor cost ranges from $ 100 to $ 7000 per vehicle, similarly real-time information providing cost varies from $ 100,000 of 156-bus system to $ 46.5 million of system having 5,700. The sensors techniques used in ITPS are as follows, 1) Static Sensor Based WSN which incorporates Multi Media based WSN, Magnetic and acoustic based WSN, Inductive loop based WSN. 2) Mobility sensor based WSN covering RFID based WSN, RF based WSN and GPRS/GSM based WSN. Selection of sensors affected by cost, latency and precision, energy utilization, synchronization, scalability.

Study carried out in Rajasthan state revels that for RSRTC's 1350 bus stands and 4476 buses the total investment in GPS WSN approximated as 1,11,90,000 INR, in GSM WSN is calculated as 87,39,000 INR, for GSM/GPRS WSN will be 1,99,29,000 INR and in case of RF TX/RX WSN it costs 35,91,600 INR in 2010-11. Hence it is observed that the initial investment in the WSN technology varies with the different available options. Researcher observed that this study will facilitate in selection of appropriate sensor suitable for IPTS requirements and constraints based on performance in developing countries.

In this article the initial investment of application of WSN has given, from which we can know that either this system can be applied in India or kept on hold due to non-availability of fund.

Singh G et al discussed the burning issue of traffic in India, due to poor road infrastructure and behavior of road users in India. Vehicular Ad-hoc Network (VANET) system applied worldwide to manage traffic congestion due to less expensive, distributive and collaborative nature. Overall cost of project reduces drastically by this system. The average speed of Indian traffic movement in cities ranging from 16 km/hr. to 20 km/hr. The VANET system can be used to detect traffic density and address the parking problems faced in most of the cities. The VANET architecture takes into account wireless connectivity of two vehicles to enhance communication. A case of Delhi demonstrates that the VANET system adaptation with Non Lane based traffic system. The VANET have a technical challenges such as security, congestion and collision control, environmental impact and infrastructure support. The other issue of Parking can also effectively addressed by VANET system. Development of parking clusters probably addresses the major issue of parking of vehicles in the city in general.

In this article VANET system is used to manage traffic congestion which is less expensive, distributive and collaborative nature. We can use this system to make ITS economically applicable.

Singh G et al presented in their paper existing techniques used in India for controlling of road traffic and ITS need in the present context. India is having non lane road traffic system where all types of vehicles are utilizing the roads which creates congestion in the traffic at various locations. Particularly, in metro cities and medium cities this traffic congestion problem is intense. In India conventional traffic management system is utilized by use of traffic lights, traffic policemen, traffic signs etc. The restriction in development in road infrastructure due to space limitation creates a hurdle in controlling the traffic congestion problem. ITS techniques used in the developed countries may not be practicable in Indian context as there is huge difference in the developed countries traffic management and Indian traffic scenario. In India instead of focusing upon fixed sensor technique, use of sensors like GPS, Wi-Fi, Camera and microphone in the smartphones can be helpful in estimating traffic conditions and avoiding the traffic congestion.

We have taken this article because for controlling traffic congestion and estimating traffic condition the fixed sensors technique, use of sensor like GPS, Wi-Fi, Camera and Microphone in the smartphones can be used.

Namaki bahar et al has carried out controlled field experiments to evaluate the relation of size of Bluetooth sensor detection zones and procedure of discovery of Bluetooth devices based upon impact on reliability and accuracy of estimated travel time. The collected data of 1000 trips for Bluetooth and global positioning system (GPS) on the reliability criteria on an average 80% of time Bluetooth devices are detected while passing through sensor location. As regards to the size of detection zone in the range of 100 m around the sensor more than 80% of detection events are captured. In case of short range antennas detection of Bluetooth devices are more accurate when they are near to the sensor which results in to precise estimation of travel time. The size of detection zone also have major impact upon penetration rate affecting the accuracy. The factors like Location of sensor installed, antenna configuration and mount design are having major impact upon the travel time estimation in terms of accuracy and reliability

From this journal we have taken the procedure of discovery of Bluetooth sensor based upon impact on reliability and accuracy of estimated time.

Kumar Praveen et al has undertaken the work of development of advanced traveler information system (ATIS) using Geographic Information System (GIS) environment. With ATIS drivers can arrange their travel route and can also estimate travel time. The optimal route or path based upon the travel distance, time can be planed based upon ATIS. The different places, landmarks, areas of the city in the form of information can be uploaded in the system in which can be use be used in the ATIS for route planning. The city bus service with all the details of origin and destinations, their timings, distance, traveling time etc. can be provided to the traveler to plan for their journey. This package has multiple applications in the form of overall geographic information combined with transportation modes and aligned information for the selection of shortest route and give other information about city.

From this article we have taken advanced traveler information system (ATIS) using Geographic (GIS).

CHAPTER 3

OBJECTIVE OF ITS

3.1 GENERAL OBJECTIVES

Intelligent Transport Systems (ITS) for roads of the Indian transport network as "intelligent" interface between roads and other transport infrastructure vitally contribute to enhancing road safety and reducing carbon emissions of the transport system by boosting the efficiency of infrastructure use and traffic operations for both passengers and freight. They also open up new perspectives for user services. TEN-T infrastructure shall be equipped with the relevant components in compliance with the Union transport policy in the field of intelligent transport systems. To support the deployment of systems which are interoperable and provide for continuity of services across Member States and operators. These measures contribute to a sustainable transport system (in terms of economic, environmental and social impacts) and connected mobility.

In the framework of the development and deployment of intelligent and increasingly automated transport systems, actions contributing to the deployment of Cooperative ITS (CITS), according to Union Regulations and standards and in line with the recommendations/outputs of the "C-ITS platform"2, shall be promoted for all Member States. C-ITS improve existing and create new ITS services, paving the road for automated vehicles, with high potential for all road users and operators while offering significant socio-economic benefits. Research projects on C-ITS have delivered promising results which have been consolidated by pilots and are increasingly considered mature for deployment.

3.2 MAIN OBJECTIVE

Over the last couple of years, there has been significant increase in the interest in ITS research. The main objective of Intelligent Transportation systems is to provide solution to the current drawbacks in transportation systems, and to provide a reliable bus service network which will attract more people to use the same, reduce air pollution by motivating people to use public transport system, it provides a lot of advantages with a modification to the current infrastructure and systems.

- To Improve Traffic Safety
- To Relieve Traffic Congestion
- To Improve Transportation Efficiency
- To Reduce Air Pollution
- To reduce the fuel consumption
- To Promote Greenery
- To Provide Better Travel Information
- To Reduce Travel Time Using Public Transport

CHAPTER-4

METHODOLGY

- **SURVEY**
- **SURVEY RESULT**
- **RESULT ANALYSIS**
- **SOLUTION OF PROBLEM**

4.1 SURVEY

To determine the major problem that Delhi is facing, we conducted survey. We prepared questionnaire to know the major problem.

Our questionnaire was:-

4.2 SURVEY RESULT

We surveyed 167 people and got the following result from the survey.

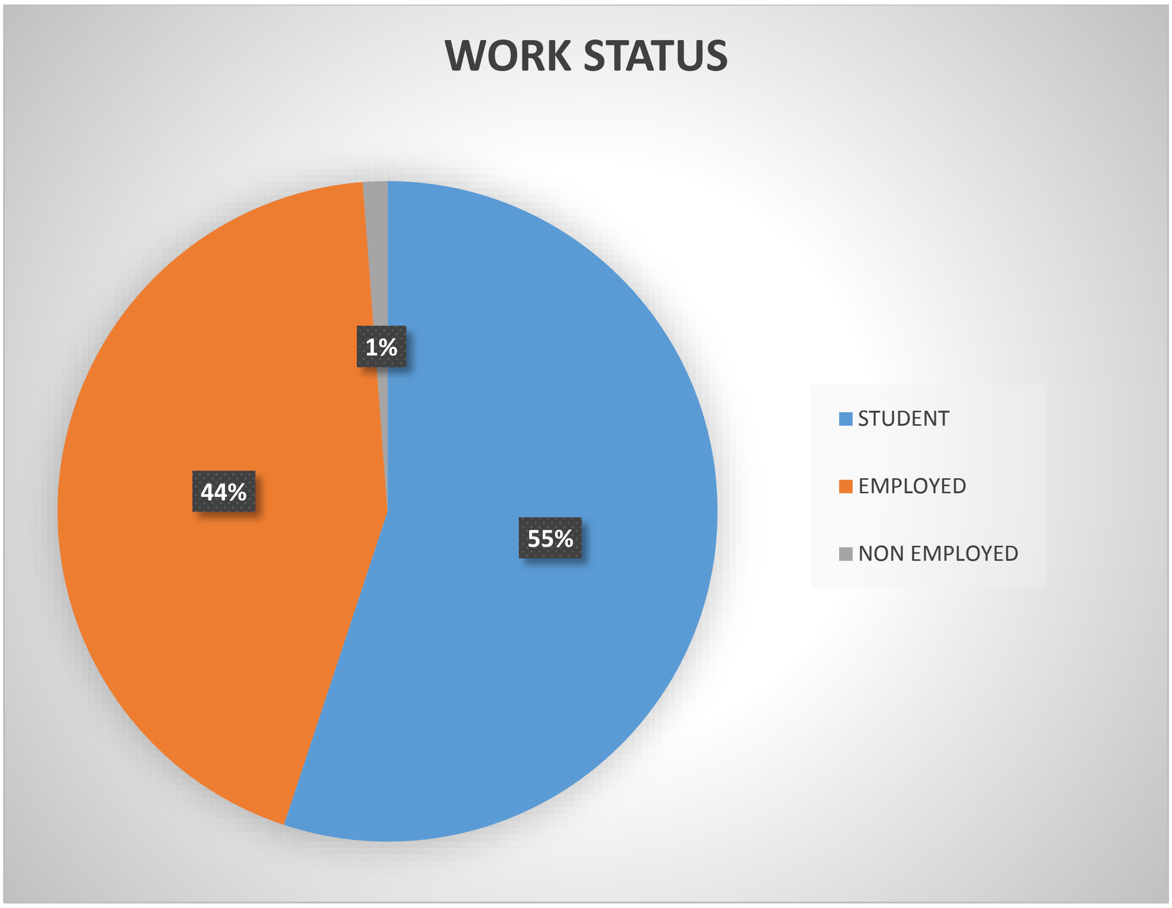

Fig No. 4.2 (1)

This survey shows the working status of people in Delhi. By this survey we can determine category of people travelling in buses. Students are majorly dependent on buses for commuting. Middle class employees are also preferring buses.

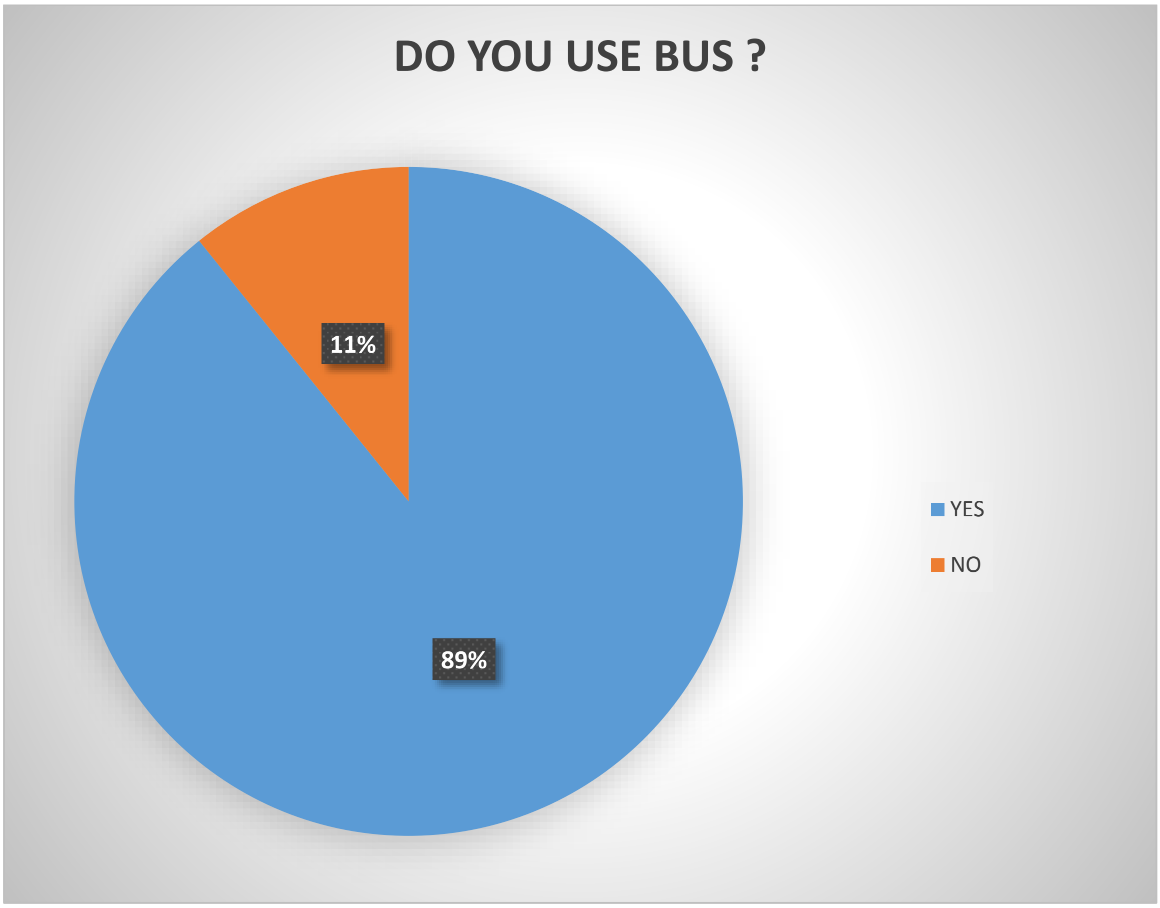

Fig No. 4.2 (2)

By the reference of this survey we determine the dependability of people on public transport (bus).

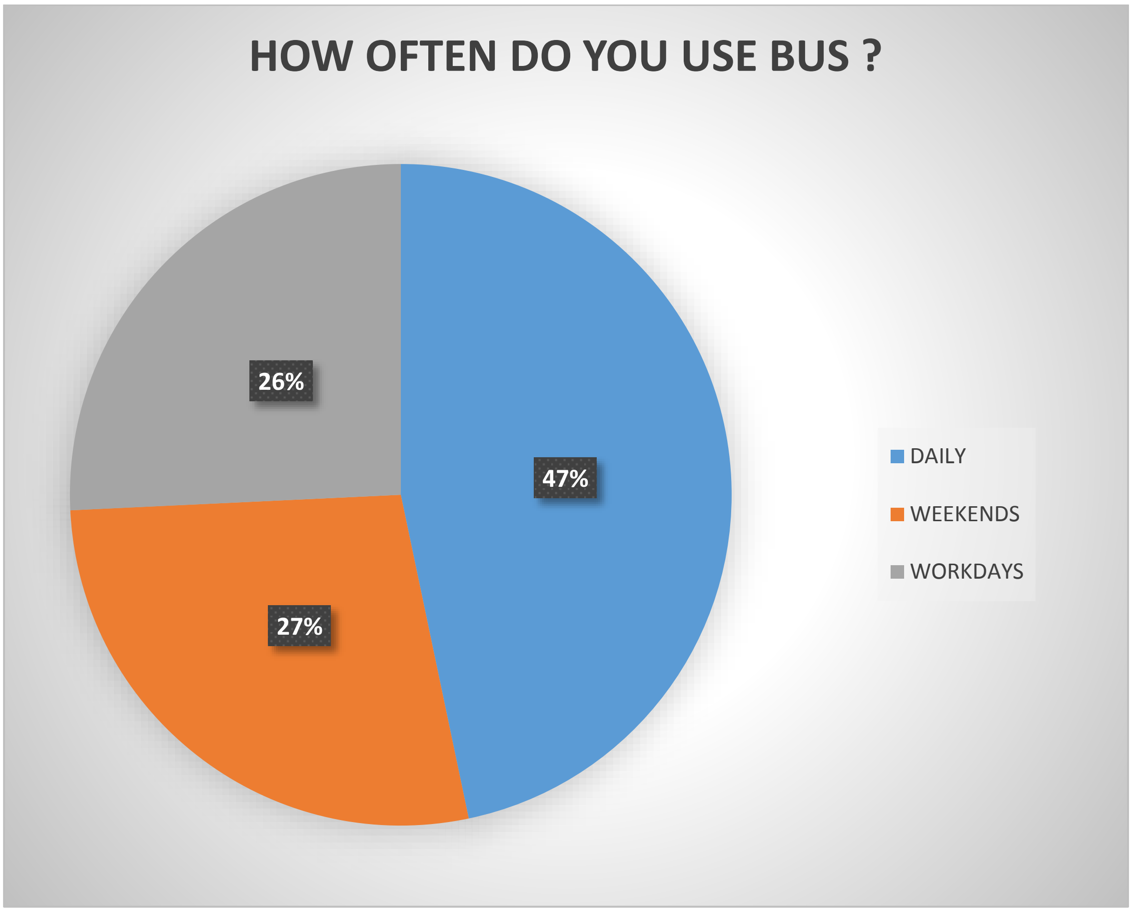

Fig 4.2 (3)

This survey shows that how often people use the public transport (bus)? By this we can also get to know ridership on various days.

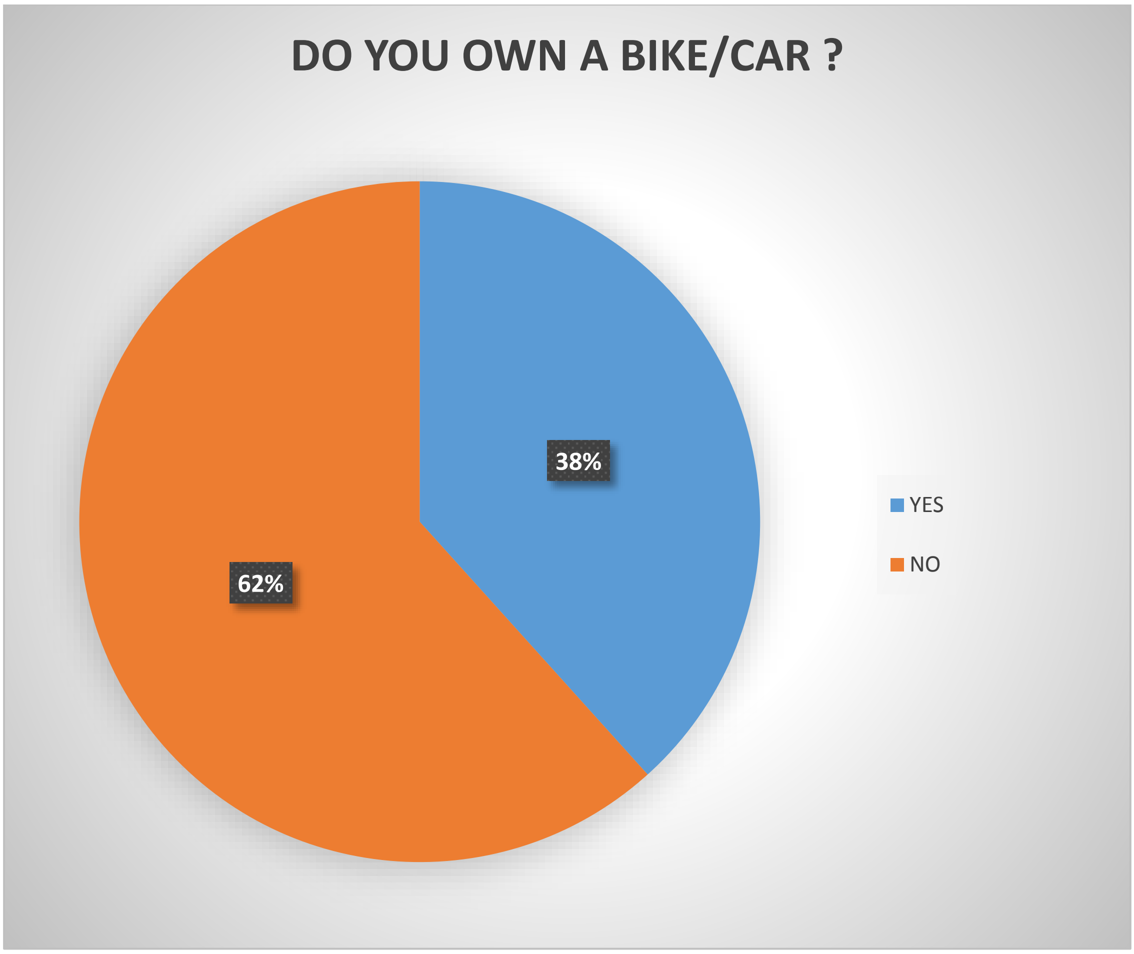

Fig No. 4.2 (4)

With the uncontrollable and daily increasing number of private vehicle (car, two wheeler) still a large section of people depends on buses.

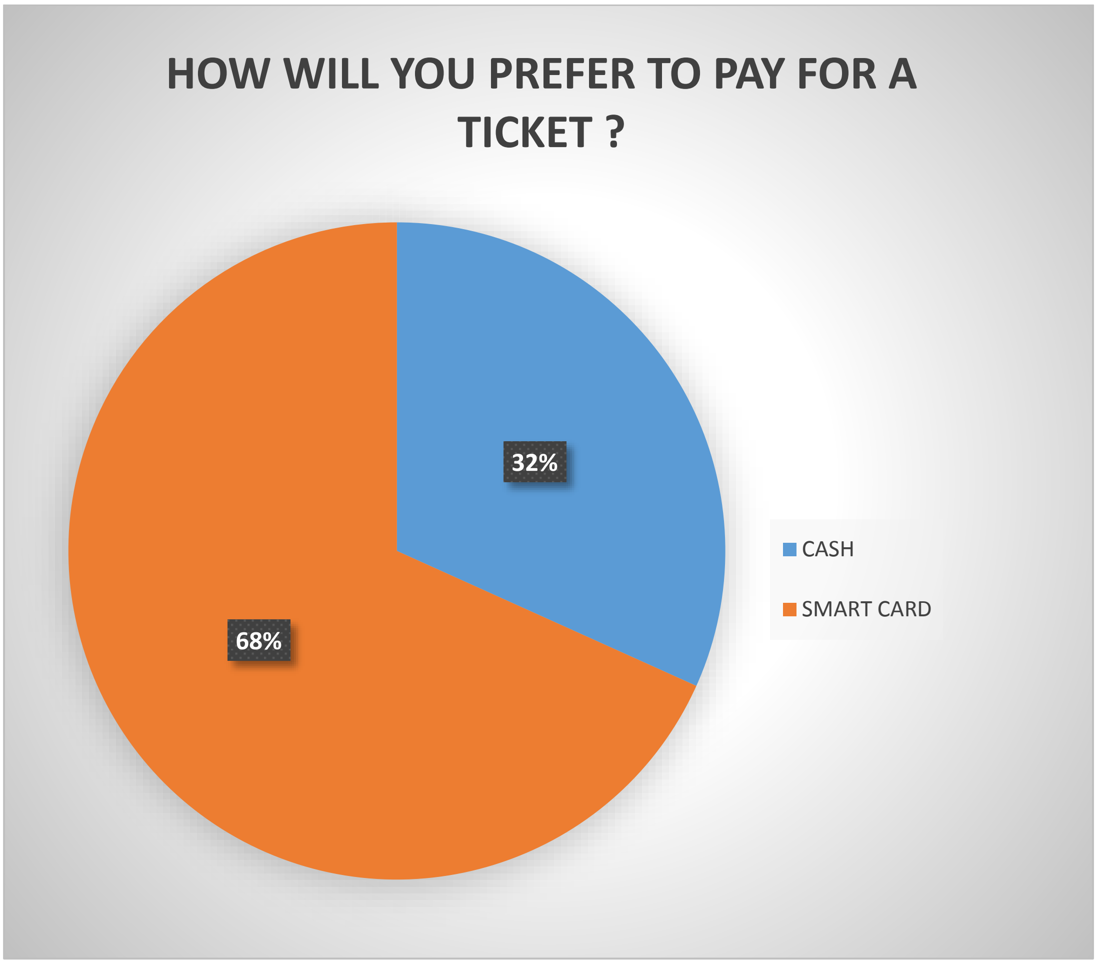

Fig No. 4.2 (5)

With the vision of **DIGITAL INDIA AND ITS**, Smart card can play a crucial role in this.

Fig No. 4.2 (6)

64 out of 167 people, who owns private vehicle showed green signal in switching towards bus if the current condition of buses improves like travel time, safety, comfort, accessibility, waiting time.

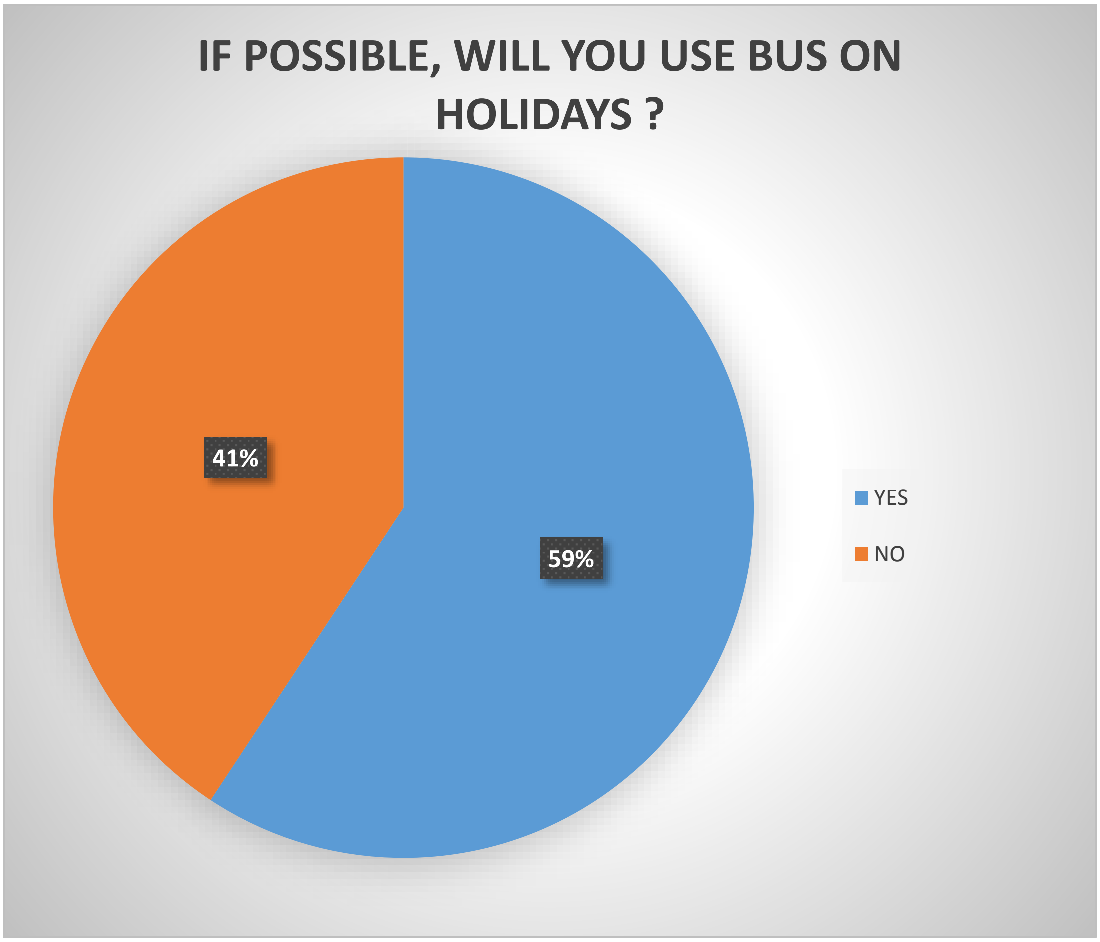

Fig No. 4.2 (7)

On holiday there is no pressure of coming on time so people show less hazzelness in using buses as a result of this the problem of overcrowding in bus reduces.

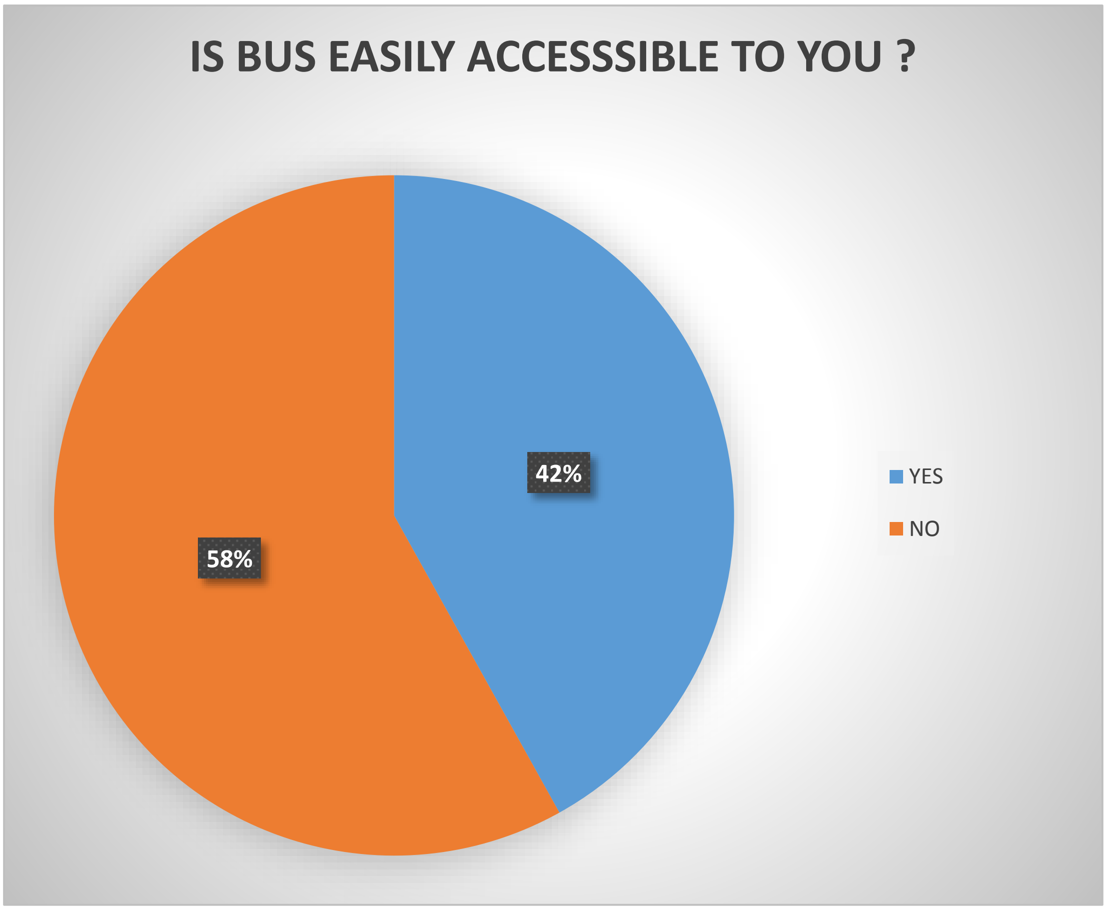

Fig No. 4.2 (8)

Even there is last mile connectivity and very wide network of buses, more than 50% of people don’t have easily accessibility to the buses.

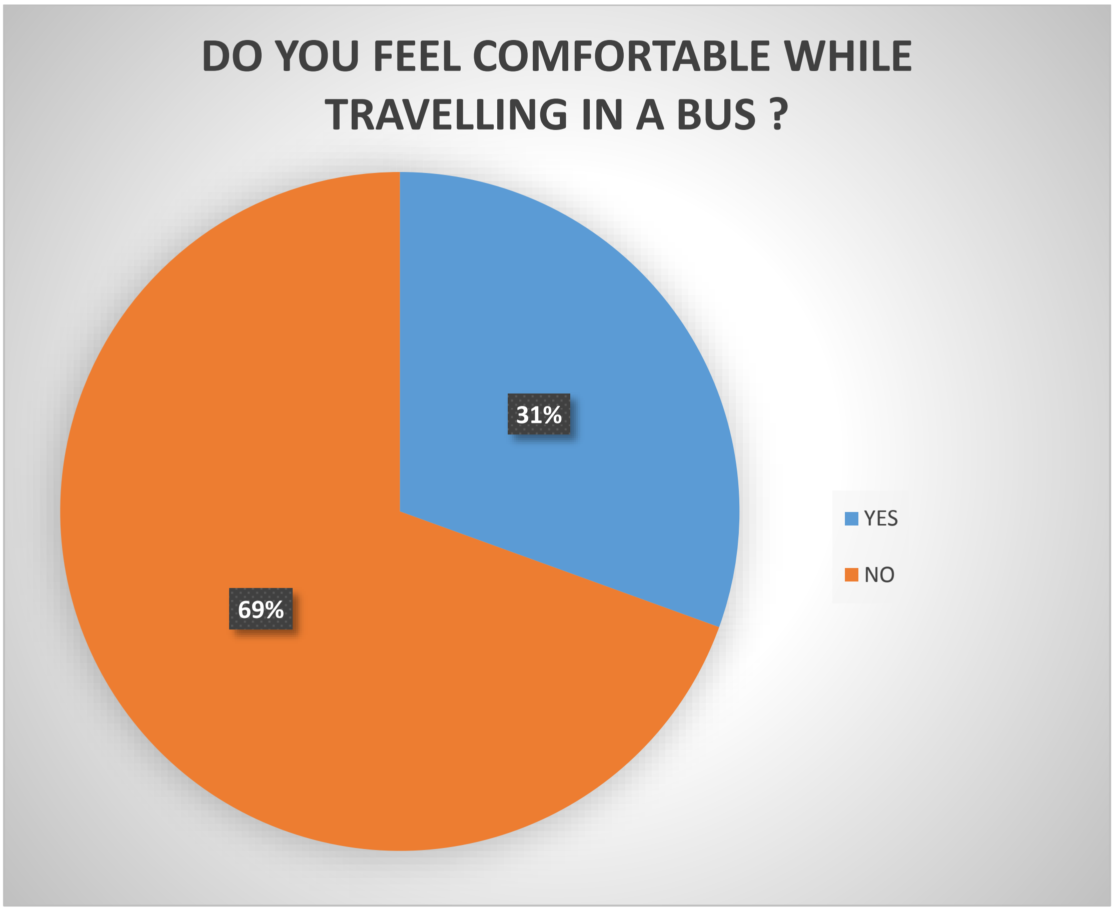

Fig No. 4.2 (9)

With no safety features like Camera, GPS, Panic button etc. People find travelling in buses not comfortable.

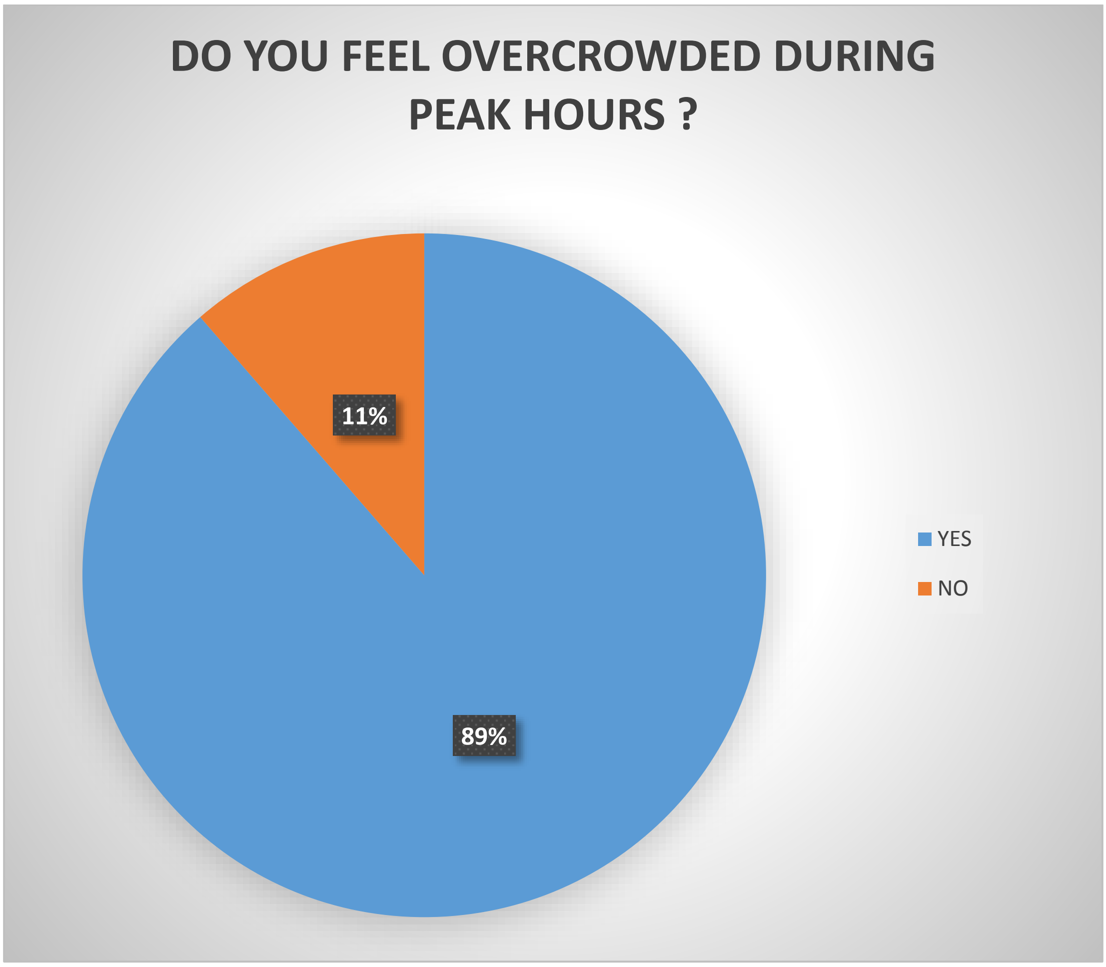

Fig No. 4.2 (10)

With the compulsion of coming on time and uncertainty of bus, passengers have no other option than just hopping on the standing bus.

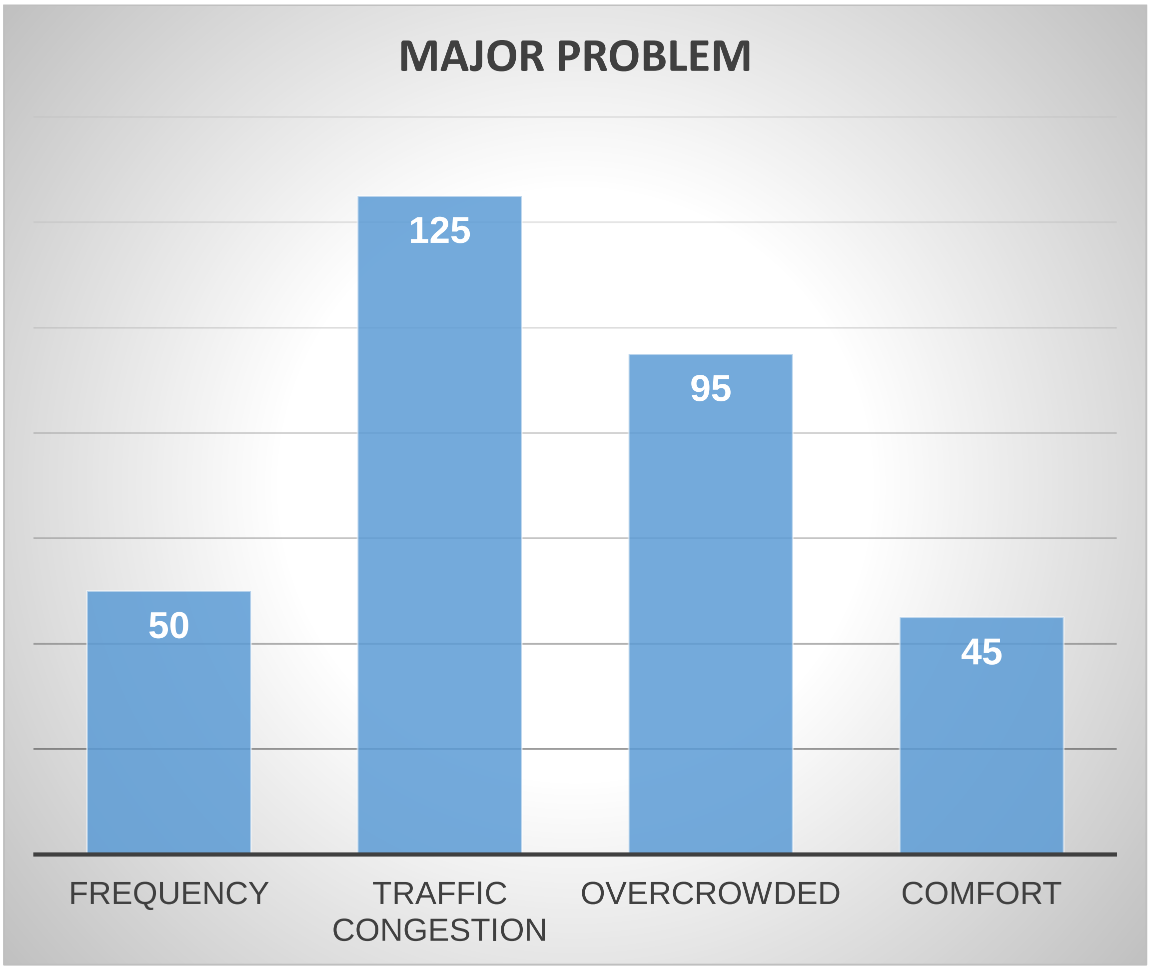

Fig No. 4.2 (11)

The survey shows that the major problem Delhi transportation faces is Traffic congestion. Overcrowding is the second major problem.

4.3 RESULT ANALYSIS

1.) Large number of people in Delhi depend upon public transport (bus). So we need to enhance the public transport.

2.) People interested in using smartcard for the bus fare instead of cash. This calls for an advance technology such as **ETM (ELECTRONIC TICKETING MACHINE).**

3.) Buses are not easily accessible to public. 58% people do not have easy access to the bus.

4.) 69% people do not feel comfortable while travelling in bus.

5.) Buses are overcrowded during peak hours. Which leads to discomfort to the public.

4.4 TRAFFIC CONGESTION

Well, one of the most common and irritating problems that one faces in the National Capital is getting caught in traffic jams. The daily commuting on the roads of Delhi is becoming longer and more gruelling day by day, depicting the failure of public transportation to keep pace with the growing developing activities in the Capital. Sad, but true, one of the fastest growing and developed cities of the world, Delhi, is also renowned for all the wrong reasons. According to a report made by IBM’s global Commuter Pain study in 2013, New Delhi is among the top 10 cities in the world having the worst traffic jams. Traffic congestion on Delhi roads presents a depressing profile of the Capital city.

4.4.1 CAUSES OF TRAFFIC CONGESTION IN DELHI

- Substantial increase in the number of vehicles on Delhi roads in recent years. In fact, studies have shown more than a lakh vehicles are plying almost every day on most of the important corridors in Delhi.
- The road length in Delhi has increased at the rate of 4.53% per year,

which, of course, is not in pace with the growing population. It is reported that the road density in Delhi is around 155 km per 100,000 population and about 80 vehicles per km.

- At the intersections, the cycle time ranges from 120 to 180 seconds, which leads to long queues, especially in the peak hours.
- Delhi roads are characterised by mixed traffic, which include, personal vehicles, buses, trucks, three-wheelers, two-wheelers, including animal-driven carts and pedestrians. This creates problems for traffic management and leads to delays in movement of the traffic.
- Increase in the growth of the population in Delhi, which includes the growing number of workforce, is another important cause.
- There has been inadequate number of bus in Delhi.
- Last, but not the least, ongoing construction of Metro network in various locations, damaged roads, repairing roads all contribute to severe traffic congestion in the city.

4.4.2 OUTCOMES OF TRAFFIC CONGESTION

- No doubt, traffic congestion is resulting into unnecessary delays and reduction in speed.
- It has resulted into a non-productive activity for most people as when they get stuck in traffic jams, they reach their workplace late or reach back home late.
- It has resulted into high rate of road traffic fatalities, making travelling and driving very unsafe in Delhi.
- Traffic congestion has also led to an increase in the number of accidents on the roads. In fact, Delhi has the highest accident rate in India and third-highest in the world.
- Traffic rules, red lights, lane driving are not followed which are both the causes and effects of traffic congestion in Delhi.
- Fuel wastage.
- Increasing air and noise pollution.
- Wear and tear on vehicles.

- Blocked traffic also interferes with the passage of emergency vehicles etc.

4.4.3 WHAT MEASURES CAN BE TAKEN?

1. **Intelligent Transport System (ITS) and Delhi Integrated Multi-Modal Transit System Ltd. (DIMTS):**

   The main objective of DIMTS is to provide safe, accessible, reliable, sustainable and user-friendly public transport for commuters and set up a mechanism to deliver public transport service that keeps pace with growth. The problem of traffic on the roads of Delhi can be solved with the implementation of Intelligent Transport System (ITS) in a proper manner, as adopted by DIMTS. It is basically the use of computer and communication technologies in the resolution of transport problems. It can help in timely gathering of data and then providing feedback to traffic managers and road-users.

   Some examples of ITS include:

   - Advanced Public Transportation Systems
   - Wireless Traffic Signal Controller
   - Red Light-Stop Line Violation & Detection System
   - CCTV Junction Surveillance
   - Variable Message Sign
   - Video Incident Detection etc.

This has already been adopted in other countries for effective management of traffic. In Delhi, it has started only recently. Proper implementation of ITS will definitely improve the scenario.

2. **Steps that need to be taken by the Government:**

   - Promoting traffic safety and traffic rules through education, advertising and strict enforcement.
   - Strict enforcement of travel demand management and policies to be adopted to reduce the use of private vehicles.

- Introduction of cost-effective, environment-friendly and efficient new modes of public transport for congested lanes, streets and feeder system for major public transport.
- Strict enforcement of travel demand management and policies to be adopted to reduce the use of private vehicles.

4.5 SOLUTION

4.5.1 DEDICATED LANES

A dedicated lane is a lane specifically demarcated with road signs and markings clearly displayed to indicate such a lane. On the dedicated lane only a particular type of vehicle is allowed. This will ensure that vehicles are afforded priority travelling.

CYCLE LANE

This is a portion of the roadway or shoulder designated for the exclusive or preferential use of bicyclists. This designation is indicated by special word and/or symbol markings on the pavement and "CYCLE LANE" signs.

OVERTAKING LANE

Overtaking lane is the lane furthest from the shoulder of a multi-lane carriageway/roadway (sometimes called the **fast lane)**.

BUS LANE

Portion of road reserved for buses providing public transportation on a fixed route, sometimes with overhead catenary for trolleybuses. In some countries, bus lanes may also be used by some other traffic, such as taxis, bicycles and motorbikes.

TRAM LANE

This lane is reserved for the use of buses, trams and taxicabs. It is usually encountered in cities with curbside tram network, such as Zagreb and sometimes in the center of the road, such as Kolkata (India).

4.6 BUS LANE

A bus lane or bus-only lane is a lane restricted to buses, often on certain days and times, and generally used to speed up public transport that would be otherwise held up by traffic congestion. Bus lanes are a key component in improving bus travel speeds and reliability by reducing delay caused by other traffic.

A dedicated bus lane may occupy only part of a roadway which also has lanes serving general automotive traffic; the related term bus way describes a roadway completely dedicated for use by buses.

Fig No.4.2(12) Bus Lane

Priorities rapid, high frequency public transport to achieve the planned outcome of moving to outstanding public transport.

Transform and elevate customer focus and experience by delivering road, public transport, cycling and walking services which are user friendly, customer oriented, and meet the needs of the people.

4.6.1 DESIGN

Bus lanes may be located in different locations on a street, such as on the sides of a street near the curb, or down the center. They may be long, continuous networks, or short segments used to allow buses to bypass bottlenecks or reduce route complexity, such as in a contraflow bus lane.

Bus lanes may be demarcated in several ways. Descriptive text such as "BUS LANE" may be marked prominently on the road surface, particularly at the beginning and end. Some cities use a diamond-shaped pavement marking to indicate an exclusive bus lane. The road surface may have a distinctive color, usually red, which has been shown to reduce prohibited vehicles from entering bus lanes, road signs may communicate when a bus lane is in effect. Bus lanes may also be physically separated from other traffic using bollards, curbs, or other raised elements.

Bus lanes may have separate sets of dedicated traffic signals, to allow transit signal priority at intersections.

Peak-only bus lanes are enforced only at certain times of the day, usually during rush hour, reverting to parking a general purpose or parking lane at other times. Peak-only bus lanes may be in effect only in the main direction of travel, such as towards a downtown during morning rush hour traffic, with the buses using general purpose lanes in the other direction.

4.6.2 ENFORCEMENT

Bus lanes can become ineffective if weak enforcement allows use by unauthorized vehicles or illegal parking.

4.6.3 EFFECTS OF BUS LANE

Bus lanes give priority to buses, cutting down on journey times where roads are congested with other traffic and increasing the reliability of buses. The introduction of bus lanes can significantly assist in the reduction of air pollution.

4.7 TRANSIT SIGNAL PRIORITY

Transit Signal Priority (TSP) is a general term for a set of operational improvements that use technology to reduce time at traffic signals for transit vehicles by holding green lights longer or shortening red lights. TSP may be implemented at individual intersections or across corridors or entire street systems.

TSP systems require four components: a detection system aboard transit vehicles; a priority request generator which can be aboard the vehicle or at a centralized management location; a strategy for prioritizing requests; and an overall TSP management system.

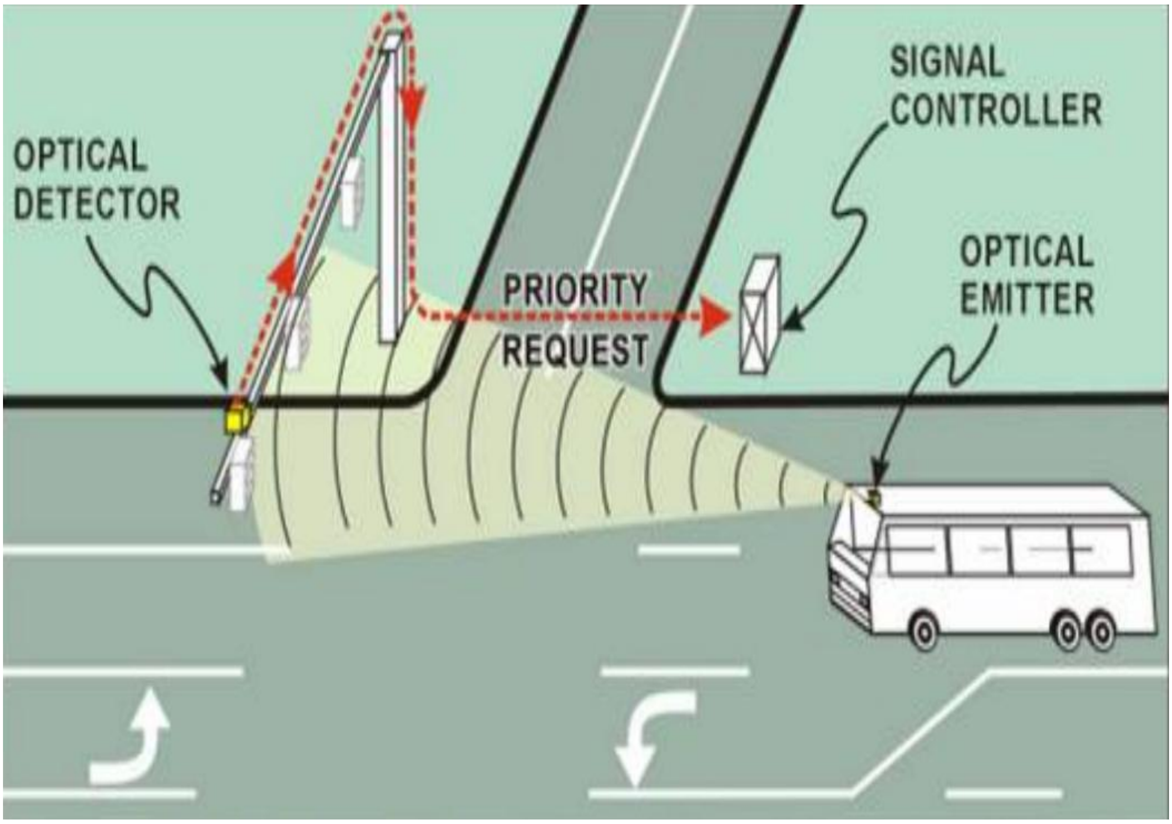

Fig No. 4.7(1) Transit Signal Priority

Transit signal priority techniques can generally be classified as "active" or "passive".

Active TSP techniques typically involve optimizing signal timing or coordinating successive signals to create a “green wave” for traffic along the transit line’s route. Active TSP techniques rely on detecting transit vehicles as they approach an intersection and adjusting the signal timing dynamically to improve service for the transit vehicle. Active TSP requires specialized hardware: the detection system typically involves a transmitter on the transit vehicle and one or more receivers (detectors), and the signal controller must be “TSP capable”, i.e. sophisticated enough to perform the required timing adjustments.

Passive techniques require no specialized hardware (such as bus detectors and specialized traffic signal controllers) and rely on simply improving traffic for all vehicles along the transit vehicle's route.

Green Extension: This strategy is used to extend the green interval by up to a preset maximum value if a transit vehicle is approaching. Detectors are located so that any transit vehicle that would just miss the green light ("just" meaning by no more than the specified maximum green extension time) extends the green and is able to clear the intersection rather than waiting through an entire red interval. Green Extension provides a benefit to a relatively small percentage of buses (only buses that arrive during a short window each cycle benefit), but the reduction in delay for those buses that do benefit is large (an entire red interval).

4.8 VEHICLE TRACKING & PASSENGER INFORMATION SYSTEM

Vehicle Tracking (VT) & Passenger Information System (PIS) Project addresses the critical issue of road congestion by adopting state-of-art technologies and attractive, convenient, comfortable, value added services to encourage the usage of bus services instead of individual personal vehicles. It aims to bring about the modal shift by improving the perceived image of current services.

The overall scope of the implementation will consist of design, development, testing, installation, commissioning, training, operations, and management of facilities. The project plans with Vehicle Tracking System for about 5,200 DTC as well as DIMTS buses, Establishment of Data Center, Control Centers, Passenger Information System, Communication Sub System, Incident and Emergency Management System.

VT & PIS will cover core systems such as Vehicle Tracking System, Real Time Passenger Information System and Central Control Centers. Core technologies include GPRS, GSM, Geographical Positioning System (GPS), Display units and Information & Communication Technologies.

4.8.1 BENEFITS OF INTRODUCING VT & PIS

Building intelligence into the transport system brings in the convergence of technologies providing a synergetic transformation in the commuter experience. VT & PIS provides benefits in terms of Reduced waiting time, Increase the accessibility of the system, Increase the passenger base, Reduce the operational costs, Improve traffic efficiency, Reduce traffic congestion by providing actual data for route planning and route rationalization.

4.8.2 BROAD OBJECTIVES

Vehicle Tracking (VT) & Passenger Information System (PIS) Project to be implemented in the state transport buses to track and monitor the movement of buses on real time basis and to enable communication of the arrival timings of buses at the bus stops.

The system provides Real-time Multi-lingual Passenger Information (Bus Timings, Expected Time of Arrival (ETA), Promotional Messages, Routes, Bus Stop data etc.) on LCD/LED Display Boards at Bus Stops, Bus Terminals and other identified locations.

Fig No. 4.8(1) Bus Stand with PIS

The users get instant access to information related to bus schedules, ETA etc., at bus stops and bus terminals through internet as well as through LCD/LED Display Boards. It helps in establishing meaningful instant 2-way interaction facility between Driver/Conductor and Control center. Obtaining real time information on bus operations and management will become easy. Also, monitoring of breakdowns and the related information has help in effective service delivery.

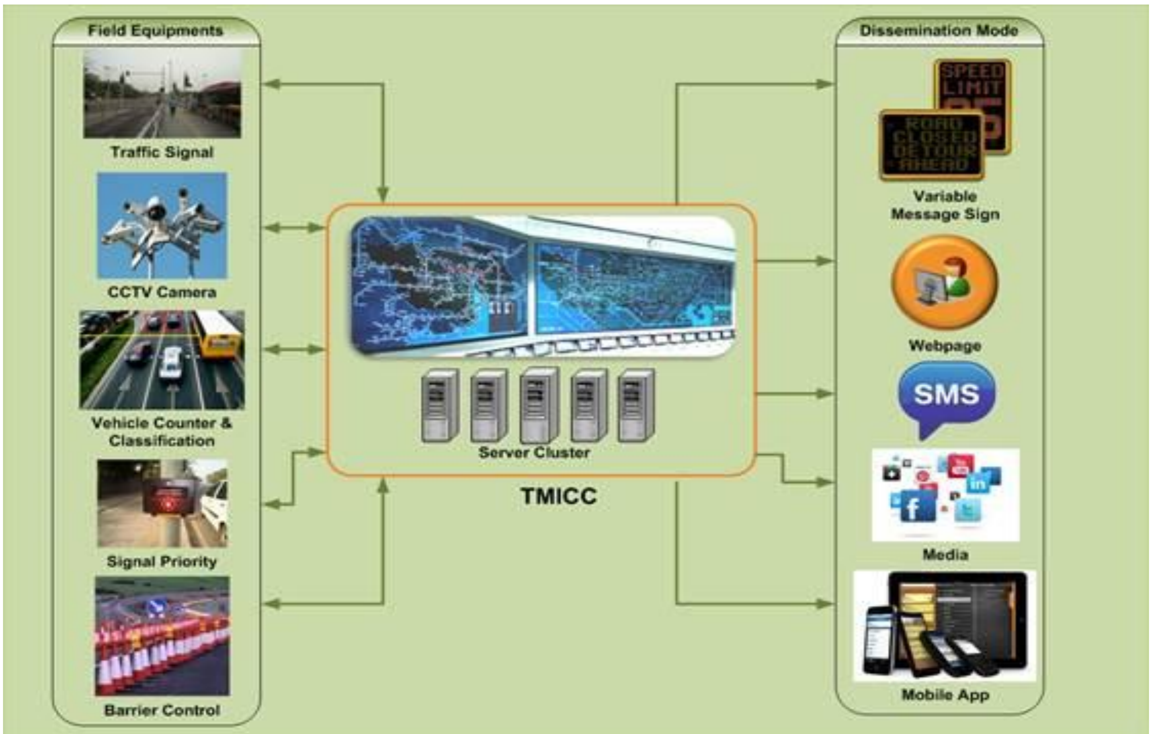

Fig No. 4.8(2) Transit Signal Priority

4.8.3 FUNCTIONALITY OF VT & PIS

GPS based Vehicle Tracking Equipment will be installed in the buses identified to be covered under the Project. The service/route in which each bus is operated will be assigned to each Vehicle Tracking device.

The geographical positional coordinates (Latitude and Longitude) are captured by the Vehicle Tracking equipment and transmitted to the Central Data Center at predetermined intervals, through GPRS, for which one SIM card will be installed in each Vehicle Tracking Unit. Based on the route on which the bus travels and its current position, the estimated time of arrival of the bus at all the subsequent stages will be calculated by the application which will be installed in the Data Center. This information will then be sent to the LED/LCD displays concerned, through GPRS for which a SIM card will be installed in the PIS controller of each LED/LCD display Unit. This information is then displayed by the Display Unit.

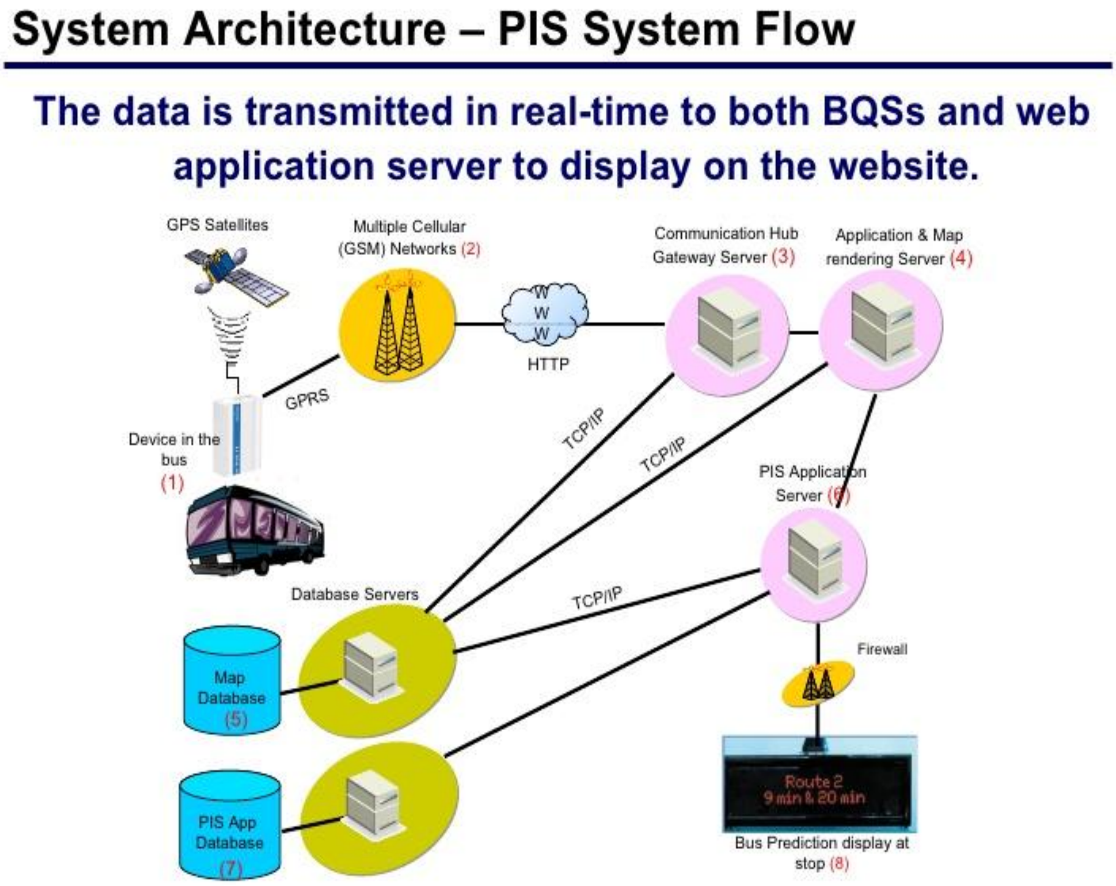

Fig No. 4.8(3)

4.9 PROJECT COMPONENTS

4.9.1 Vehicle Tracking System (VTS) with real-time connectivity:

Global Positioning System (GPS) based Vehicle Mounted Unit (VMU) will form the core of the VTS. The VMU Unit records and transfer vehicle movement data (Latitude/Longitude coordinates) with time stamp to a central server through GSM/GPRS network.

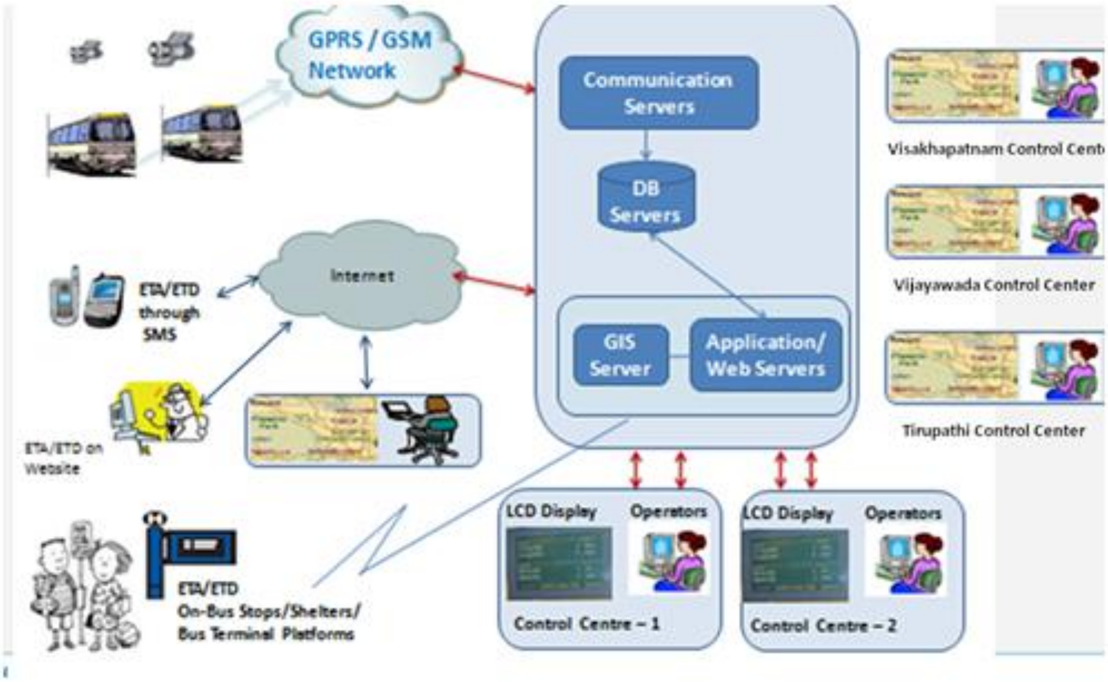

Fig No. 4.9(1) VT & PIS: SOLUTION PERSPECTIVE

4.9.2 Passenger Information System (PIS)

LCD/LED Display Boards installed at Bus Stations, Bus Shelters and other locations displays real time information of arrival and departure of the Buses at the Bus stops and Bus Stands.

4.9.3 Mobile Application

Those with smart phones can download a mobile application or check out the website to find when the bus will come at their station.

In-bus display, Stage Announcement and Recording

In bus destination boards and voice announcement is provided in city buses for displaying information about the current stop and next stop and voice announcement of the same. This information will be based on the Latitude/Longitude of the bus and the next bus stop. On-board cameras with recording facility in city buses for recording the events/happenings in the buses for later viewing and analysis.

Fig No. 4.9(2) Display/Recording

4.9.4 Data center, Control centers

Data center receives transactional data from device applications into servers hosting VTS, and decision support applications respectively to generate alerts and reports on revenue and schedule parameters aiding in analyzing through a centralized web solution for different users. Central Control Room established act as live hubs to manage and monitor service related data which will be viewable through a centralized web application on PC's and LCD Displays.

4.9.5 Depot Application

Depot Level Applications to support the above systems enable the monitoring and control of the system at the depot level and hence manage the operations in a better way. The current schedules are assigned using the web application at depots.

4.9.6 Conclusion

With the introduction of VT&PIS Project, DTC & DIMTS are now able to manage the entire fleet operations more efficiently through on-line remote access to vehicle positions, speed, breakdown, accident/ incident, etc and make appropriate decisions using the MIS reports that support all levels of management in decision making.

Managing emergency situations has become better by monitoring emergency incident /accident management in real-time. Performance of the bus fleet has improved by monitoring adherence to schedule, route, missed trips, late trips on different routes, break downs and its duration, vehicles offline, accidents – types, impact, losses etc., improper stops at bus stops, driver behavior, deviation in routes, speed violations, at different locations and at different points of time.

4.10 Electronic toll collection (ETC)

It aims to eliminate the delay on toll roads by collecting tolls electronically. ETC determines whether the cars passing are enrolled in the program, alerts enforcers for those that are not, and electronically debits the accounts of registered car owners without requiring them to stop.

Electronic toll collection has facilitated the concession to the private sector of the construction and operation of urban freeways. Also, it has made feasible the improvement and the practical implementation of road congestion pricing schemes in a limited number of urban areas to restrict auto travel in the most congested areas.

Cashless tolling has cash tolls not collected on the roadway. Electronic toll collection becomes the primary option for payment, with payment by mail as a secondary option. Open road tolling (ORT) is a type of electronic toll collection without the use of toll booths. The major advantage to ORT is that users are able to drive through the toll plaza at highway speeds without having to slow down to pay the toll.

Enforcement is accomplished by a combination of a camera which takes a picture of the car and a radio frequency keyed computer which searches for a driver's window/bumper mounted transponder to verify and collect payment. The system sends a notice and fine to cars that pass through without having an active account or paying a toll.

Factors hindering full-speed electronic collection include significant non-participation, entailing lines in manual lanes and disorderly traffic patterns as the electronic- and manual- collection cars "sort themselves out" into their respective lanes; problems with pursuing toll evaders; need, in at least some current (barrier) systems, to confine vehicles in lanes, while interacting with the collection devices, and the dangers of high-speed collisions with the confinement structures; vehicle hazards to toll employees present in some electronic-collection areas; the fact that in some areas at some times, long lines form even to pass through the electronic-collection lanes; and costs and other issues raised when retrofitting existing toll collection facilities. Unionized toll collectors can also be problematic.

Even if line lengths are the same in electronic lanes as in manual ones, electronic tolls save registered cars time. Eliminating the stop at a window or toll machine, between successive cars passing the collection machine, means a fixed-length stretch of their journey past it is traveled at a higher average speed, and in a lower time. This is at least a psychological improvement, even if the length of the lines in automated lanes is sufficient to make the no-stop-to-pay savings insignificant compared to time still lost due waiting in line to pass the toll gate. Toll plazas are typically wider than the rest of the highway; reducing the need for them makes it possible to fit toll roads into tight corridors.

Despite these limitations, however, it is important to recognize that throughput increases if delay at the toll gate is reduced (*i.e.*, if the tollbooth can serve more vehicles per hour). The greater the throughput of any toll lane, the fewer lanes required, so expensive construction can be deferred. Specifically, the toll-collecting authorities have incentives to resist pressure to limit the fraction of electronic lanes in order to limit the length of manual-lane lines. In the short term, the greater the fraction of automated lanes, the lower the cost of operation (once the capital costs of automating are amortized). In the long term, the greater the relative advantage that registering and turning one's vehicle into an electronic-toll one provides, the faster cars will be converted from manual-toll use to electronic-toll use, and therefore the fewer manual-toll cars will drag down average speed and thus capacity.

In some countries, some toll agencies that use similar technology have set up (or are setting up) reciprocity arrangements, which permit one to drive a vehicle on another operator's tolled road with the tolls incurred charged to the driver's toll-payment account with their home operator. An example is the United States E-ZPass tag, which is accepted on toll roads, bridges and tunnels in fifteen states from Illinois to Maine.

Fig No. 4.10(1) Electronic toll gate collection

4.10.1 TECHNOLOGIES

Electronic toll collection systems rely on four major components: automated vehicle identification, automated vehicle classification, transaction processing, and violation enforcement.

The four components are somewhat independent, and, in fact, some toll agencies have contracted out functions separately. In some cases, this division of functions has resulted in difficulties. In one notable example, the New Jersey E-ZPass regional consortium's Violation Enforcement contractor did not have access to the Transaction Processing contractor's database of customers. This, together with installation problems in the automated vehicle identification system, led to many customers receiving erroneous violation notices, and a violation system whose net income, after expenses, was negative, as well as customer dissatisfaction.

- **AUTOMATED VEHICLE IDENTIFICATION**

Automated vehicle identification (AVI) is the process of determining the identity of a vehicle subject to tolls. The majority of toll facilities record the passage of vehicles through a limited number of toll gates. At such facilities, the task is then to identify the vehicle in the gate area.

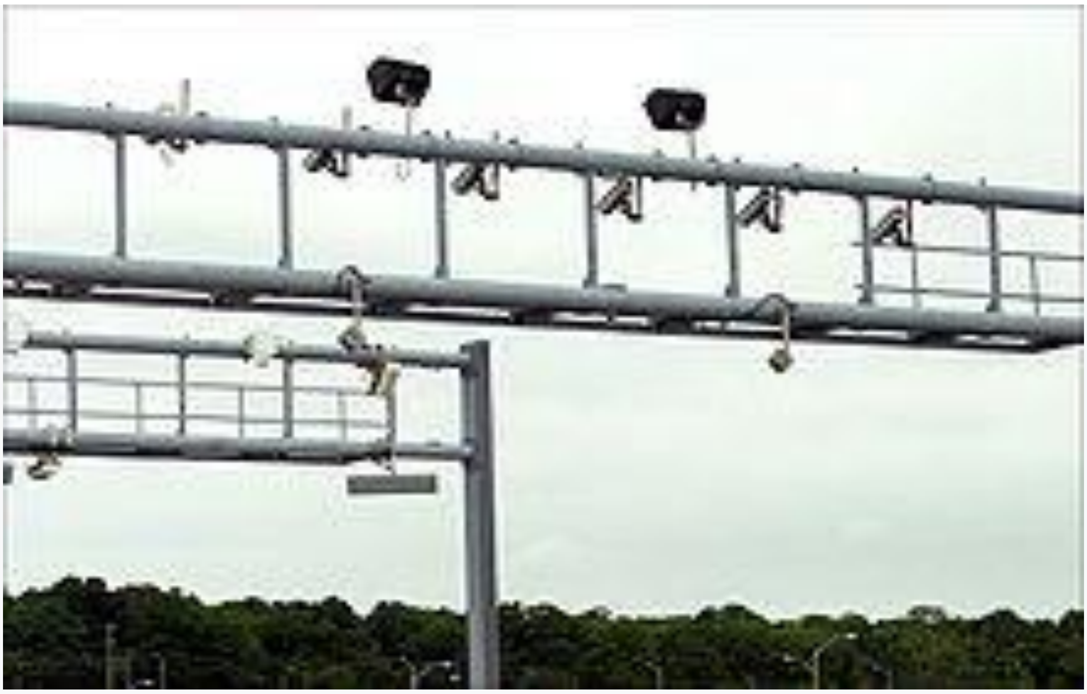

Fig no. 4.10(2) automated vehicle identification

Some early AVI systems used barcodes affixed to each vehicle, to be read optically at the toll booth. Optical systems proved to have poor reading reliability, especially when faced with inclement weather and dirty vehicles.

Most current AVI systems rely on radio-frequency identification, where an antenna at the toll gate communicates with a transponder on the vehicle via Dedicated Short Range Communications (DSRC). RFID tags have proved to have excellent accuracy, and can be read at highway speeds. The major disadvantage is the cost of equipping each vehicle with a transponder, which can be a major start-up expense, if paid by the toll agency, or a strong customer deterrent, if paid by the customer.

❖ AUTOMATED VEHICLE CLASSIFICATION

Automated vehicle classification is closely related to automated vehicle identification (AVI). Most toll facilities charge different rates for different types of vehicles, making it necessary to distinguish the vehicles passing through the toll facility.

The simplest method is to store the vehicle class in the customer record, and use the AVI data to look up the vehicle class. This is low-cost, but limits user flexibility, in such cases as the automobile owner who occasionally tows a trailer.

More complex systems use a variety of sensors. Inductive sensors embedded in the road surface can determine the gaps between vehicles, to provide basic information on the presence of a vehicle. Treadles permit counting the number of axles as a vehicle passes over them and, with offset-treadle installations, also detect dual-tire vehicles. Light-curtain laser profilers record the shape of the vehicle, which can help distinguish trucks and trailers.

❖ TRANSACTION PROCESSING

Transaction processing deals with maintaining customer accounts, posting toll transactions and customer payments to the accounts, and handling customer inquiries. The transaction processing component of some systems is referred to as a "customer service center". In many respects, the transaction processing function resembles banking, and several toll agencies have contracted out transaction processing to a bank.

Customer accounts may be postpaid, where toll transactions are periodically billed to the customer, or prepaid, where the customer funds a balance in the account which is then depleted as toll transactions occur. The prepaid system is more common, as the small amounts of most tolls makes pursuit of uncollected debts uneconomic. Most postpaid accounts deal with this issue by requiring a security deposit, effectively rendering the account a prepaid one.

- **VIOLATION ENFORCEMENT**

A violation enforcement system (VES) is useful in reducing unpaid tolls, as an unmanned toll gate otherwise represents a tempting target for toll evasion. Several methods can be used to deter toll violators.

Police patrols at toll gates can be highly effective. In addition, in most jurisdictions, the legal framework is already in place for punishing toll evasion as a traffic infraction. However, the expense of police patrols makes their use on a continuous basis impractical, such that the probability of being stopped is likely to be low enough as to be an insufficient deterrent.

A physical barrier, such as a gate arm, ensures that all vehicles passing through the toll booth have paid a toll. Violators are identified immediately, as the barrier will not permit the violator to proceed. However, barriers also force authorized customers, which are the vast majority of vehicles passing through, to slow to a near-stop at the toll gate, negating much of the speed and capacity benefits of electronic tolling.

Automatic number plate recognition, while rarely used as the primary vehicle identification method, is more commonly used in violation enforcement. In the VES context, the number of images collected is much smaller than in the AVI context. This makes manual review, with its greater accuracy over fully automated methods, practical. However, many jurisdictions require legislative action to permit this type of enforcement, as the number plate identifies only the vehicle, not its operator, and many traffic enforcement regulations require identifying the operator in order to issue an infraction.

An example of this is the vToll system on the Illinois Tollway, which requires transponder users to enter their license plate information before using the system. If the transponder fails to read, the license plate number is matched to the transponder account, and the regular toll amount is deducted from the account rather than a violation being generated. If the license plate can't be found in the database, then it is processed as a violation. An interesting aspect of Illinois' toll violation system is a 7-day grace period, allowing tollway users to pay missed tolls online with no penalty the 7 days following the missed toll.

In the United States, a growing number of states are sharing information on toll violators, where toll agencies can report out-of-state toll violators to the Department of Motor Vehicles (or similar agency) of the violator's home state. The state motor vehicle agency can then block the renewal of the vehicle's registration until the violator has paid all outstanding tolls, plus penalties and interest in some situations. Toll authorities are also resorting to using collection agencies and litigation for habitual toll violators with large unpaid debts, and some states can pursue criminal prosecution of repeat toll violators, where the violator could serve time in jail, if convicted. Many toll agencies also publicize a list of habitual toll violators through media outlets and newspapers. Some toll agencies offer amnesty periods, where toll violators can settle their outstanding debts without incurring penalties or being subject to litigation or prosecution.

CHAPTER 5

CONCLUSION

Explosive growth in traffic density and population has raised various issues such as air pollution, congestion and accidents that have become the area of research. Hence Intelligent Transport System (ITS) is used to solve these transport related issues. ITS combines various technologies such as data collection, communication, machine learning and data mining to provide transport related services. These services include Traffic control, navigation systems, driver assistance systems and Fault detection systems. In addition to this ITS also solves transport related issues such as disaster management, congestion control and air pollution. Further enhancement in ITS include addition of new techniques such as internet of vehicles, vehicular cloud computing, Agent based computing which includes the introduction of Artificial Transport System. By combining these techniques the ITS can be made more efficient in solving transport related problems. ITS program hinges following development:

- **MODELLING OF INDIAN TRAFFIC**: A proper understanding of the traffic system is important to the successful management and operation of its in India. The existing models, development of western traffic condition may not be applicable for Indian traffic and hence there is a need to modify or develop models that can be characterize the Indian traffic in better way.
- **SUPPLY CHAIN:** Seamless interconnectivity of the various branches of the transportation sector is essential to provide effective, efficient and secure movement of goods and service while improving the conservation of natural resources and reducing environmental impact such as air pollution.

- **PRODUCTIVITY:** Congestion lowers productivity, causes flow-on delays in supply chains and increase the cost of business. ITS can increase productivity by finding innovative ways to increase the capacity of our current infrastructure

- **PROMOTE ECO-FRIENDLY TRANSPORT:** ITS technologies are focused on fuel-efficient operation of vehicle and traffic management system to achieve better fuel economy and lower tailpipe emission without compromising the safety of driver or other road user.
- **HUMAN CAPITAL DEVELOPMENT:** Human skills are important to ensure the development of seamless transportation system. Given the population density of India and the varied sets available in the country, the ability of work force to develop, manage and safety implement existing and emerging technologies is essential for ITS design and implemented.

CHAPTER 6

FUTURE SCOPE OF ITS

Imagine driving your way through the monstrous bumper to bumper Delhi traffic. Blasting horns, reckless Blue lines, motorcycles whizzing past, endless auto rickshaws, lazy Bullocks vying for space there's no solution to the complete chaos and madness. It's just not Delhi's story, keeping traffic moving is a problem faced globally at all the levels of government. However the good news is that solution may just be round the corner with the implementation of Intelligent Transport System ITS.

6.1 FUTURE TRANSPORT (ENVIRONMENT FRIENDLY TRANSPORT):

There is an increasing understanding globally that mobility and transport must be delivered with long-term responsibility for the environment and climate. The world financial crisis is an extra dimension increasing the pressure for measures to be efficient and effective. Transport development so far has tended to be for each mode of transport to act for itself in competition with other modes, seeking to gain market share and a more prominent place in the national and the international markets. It is now legitimate to question this and ask whether competition among the modes should not end so that freight shipment or passenger trips can be brought into focus from a customer perspective with the long-term responsibility for the environment and climate. ITS is a key tool for such a change and it is paramount that the ITS solutions which emerge offer an overall multimodal transport benefit and that incentives for implementation are created both nationally and internationally.

6.2 FOR ENERGY EFFICIENCY AND CLIMATE CHANGE MITIGATION:

Across the world the green aspect of transport is becoming more and more a feature of public debate. ITS potentially has both direct and indirect positive impacts on the demand for transport, energy consumption and environmental externalities. It also has an important role to play in the deployment of alternative fuels and propulsion systems and promoting co-modal transport.

However, significant results and quantitative data are still missing. At present, only a few systems specifically address environmental aspects. Tangible results are needed to support the wider deployment of these «Green ITS» services. This session will address current actions at an international political and strategic level to meet environmental requirements with ITS, including possible actions under the European Green Cars Initiative proposed as part of the European Economic Recovery Plan, the concept of Green Corridors as well as the Japanese and US initiatives on transport technologies.

6.3 URBAN MOBILITY:

Intelligent transport systems can improve traffic flow, safety and public transit in cities. They also enable informed choices by users. Deployment has been limited given the scale of urban mobility needs, including reduction of emissions and other environmental concerns. Moreover, some older traffic management and information systems are often not capable of integrating real-time information on congestion or traffic incidents. This session will review emerging urban mobility technologies and address the economic benefit of changes in the navigation, telematics and traffic control industries. It will also elaborate on how intelligent transportation technologies can support the needs for increased mobility as well as benefit the environment.

6.4 DRIVER DISTRACTION:

Driving along intricate networks of roadways with numerous inputs such as road signs, commercial advertisements, unpredictable pedestrians and other distractions has become a challenge for even the best drivers. Vehicle infotainment and communications systems present an array of functionalities that also potentially distract drivers. Older drivers are especially challenged by these operating conditions. While the driver may be cognitively limited in order to deal with these challenges, it may be possible to use technology to make the vehicle and infrastructure smarter. This includes reference to human factor concepts of safety and security, cognitive distraction, overdependence on such systems, and misunderstanding system functionalities. This session will focus on using ITS and human factors engineering principles to deal with driver distraction. The benefits and shortcomings of using these technologies as well as the political implications of potential deployment will be discussed.

6.5 FUNDING FOR TRANSPORTATION INFRASTRUCTURE AND ITS:

Financing transportation infrastructure and deployment of intelligent transportation technologies present great challenges, now brought into sharper focus by the current global economic crisis. Fuel taxes, for example, are becoming less efficient means to raise infrastructure capital and operating funds. Private investors are seeking realistic business models to justify investments in infrastructure. Political leaders are demanding “performance measurements” or what private investors seek in commercial terms: the highest return-on investment. This session will address economic factors affecting various funding mechanisms and potential public policy strategies and business models to attract private investors. The advantages and disadvantages of various funding mechanisms as well as public reactions and political implications will be assessed.

6.6 TO IMPROVE LOCAL AIR QUALITY AND REDUCE GLOBAL WARMING

For many cities emissions from road transport are a difficult problem. The emissions from vehicles affect citizen’s health but also are a growing cause to global warming. There is a great need for methods and techniques to calculate and to process emission data to support management strategies. ITS can play an important role in supporting these efforts. This session will give examples on how new strategies and methods have been deployed in Stockholm and London. Greenhouse gas reduction strategies incorporating ITS for congestion charging, mobility management, goods logistics and stimulating more people to use public transport and clean alternative fuelled vehicles will be described. The session will also present new high resolution ITS based techniques to collect and to process ambient pollution data for new approaches to traffic management.

6.7 REDUCING GREENHOUSE EMISSIONS AND FUEL CONSUMPTION:

Climate change is rapidly becoming known as a tangible issue that must be addressed to avoid major environmental consequences in the future. Recent change in public opinion has been caused by the physical signs of climate change-melting glaciers, rising sea levels, more severe storm and drought events, and hotter average global temperatures annually. Transportation is a major contributor of carbon dioxide and other greenhouse gas emissions from human activity, accounting for approximately 14% of total anthropogenic emissions globally and about 27% in the USA. Fortunately, transportation technologies and strategies are emerging that can help meet the climate challenge. These include automotive and fuels technologies, intelligent transportation systems (ITS), and mobility management strategies that can reduce the demand for private vehicles. This session will explore the role of each of these key strategies and the interplay among them.

REFERENCES

- Delhi Integrated Multi Modal Transit System (DIMTS)
- Delhi Transport Corporation (DTC)
- Auckland Transport Corporation
- Economic Survey Delhi
- Synthesis report on INTELLIGENT TRANSPORTATION SYSTEM by IIT MADRAS
- Master thesis on INTELLIGENT TRANSPORTATION SYSTEM by *Kay Noyen*
- A Survey on Intelligent Transportation Systems by *Kashif Naseer Qureshi and Abdul Hanan Abdullah*, Department of Communication, Faculty of Computing,Universiti Teknologi Malaysia, Skudai, 81310, Johor Darul Takzim, Malaysia
- Imperial Journal of Interdisciplinary Research (IJIR) Vol-2, Issue-10, 2016 ISSN: 2454-1362, http://www.onlinejournal.in

REFERENCES FOR ELECTRONIC TOLL COLLECTION

- *Kelly, Frank (2006). "Road Pricing: Addressing congestion, pollution and the financing of Britain's road." Ingenia. The Royal Academy of Engineering.*
- *Roth, Gabriel (2008). "Roads in a Market Economy". In Jordi, Philipp. Institutional Aspects of Directive 2004/52/EC on the Interoperability of Electronic Road Toll Systems in the Community. Europainstitut der Universität Basel.*
- Copeland, Larry, Toll roads take cashless route, USA Today, 7/28/2008.
- *Poole Jr., Robert W. (November 6, 2007). "Life in the Slow Lane". Wall Street Journal.*
- *European Parliament; European Council (April 29, 2004). "Directive 2004/52/EC of the European Parliament and of the Council of 29 April 2004 on the interoperability of electronic road toll systems in the Community". EUR-Lex. European Union. Retrieved March 8, 2012.*

REFERENCES FOR PASSANGER INFORMATION SYSTEM

- *Ferris, Brian; Watkins, Kari; Borning, Alan (2010-01-01). "OneBusAway: Results from Providing Real-time Arrival Information for Public Transit". Proceedings of the SIGCHI Conference on Human Factors in Computing Systems. CHI '10. New York, NY, USA: ACM: 1807–1816. doi:10.1145/1753326.1753597. ISBN 9781605589299.*
- *Brakewood, Candace; Macfarlane, Gregory S.; Watkins, Kari (2015-04-01). "The impact of real-time information on bus ridership in New York City". Transportation Research Part C: Emerging Technologies.* ***53****: 59–75. doi:10.1016/j.trc.2015.01.021.*
- *Tang, Lei; Thakuriah, Piyushimita (Vonu) (2012-06-01). "Ridership effects of real-time bus information system: A case study in the City of Chicago". Transportation Research Part C: Emerging Technologies.* ***22****: 146–161. doi:10.1016/j.trc.2012.01.001.*
- *Schweiger, Carol L.; Program, Transit Cooperative Research (2003-01-01). Real-time Bus Arrival Information Systems. Transportation Research Board. ISBN 9780309069656*
- *"DB BAHN - Abfahrt und Ankunft". Bahn.de. Retrieved 2014-06-28.*
- *"Verkehrsverbund Rhein-Ruhr - Fahrten planen". Vrr.de. Retrieved 2014-06-28.*

ANNEXURE

PASSENGER SATISFACTION SURVEY

1. Name

2. Age

3. Work Status

- ◯ Student
- ◯ Non-employed
- ◯ Employed
- ◯ Sr. Citizen

4. Do you use bus?

- ◯ Yes
- ◯ No

5. How often do you use bus?

- ◯ Daily
- ◯ Weekdays
- ◯ Weekend
- ◯ Once in a month

6. Do you own a private vehicle?

- ◯ Yes
- ◯ No

7. How would you prefer to pay for a ticket?

- ◯ Cash
- ◯ Smart Cards(as in METRO)

8. If your car/bike is not available,will you prefer using bus?

- ◯ Yes
- ◯ No

9. If possible,will you use bus on holidays?

- ◯ Yes
- ◯ No

10. Is bus easily accessible to you?

- ◯ Yes
- ◯ No

11. Do you feel comfortable while travelling in bus?

- ◯ Yes
- ◯ No

12. Do you feel overcrowded during peak hours?

- ◯ Yes
- ◯ No

13. How would you rate the followings of a bus:

	Good	Fair	Bad	Very Bad
Cleanliness	◯	◯	◯	◯
Travel Time	◯	◯	◯	◯
Safety	◯	◯	◯	◯
Waiting Time	◯	◯	◯	◯
Staffs Behaviour	◯	◯	◯	◯

14. Major problem that a bus is facing?

- ◯ Frequency
- ◯ Overcrowded
- ◯ Poor Maintenance
- ◯ Traffic Congestion
- ◯ Comfort/Safety

15. Will you suggest anyone to use bus?

- ◯ Yes
- ◯ No